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APR-CALKIT

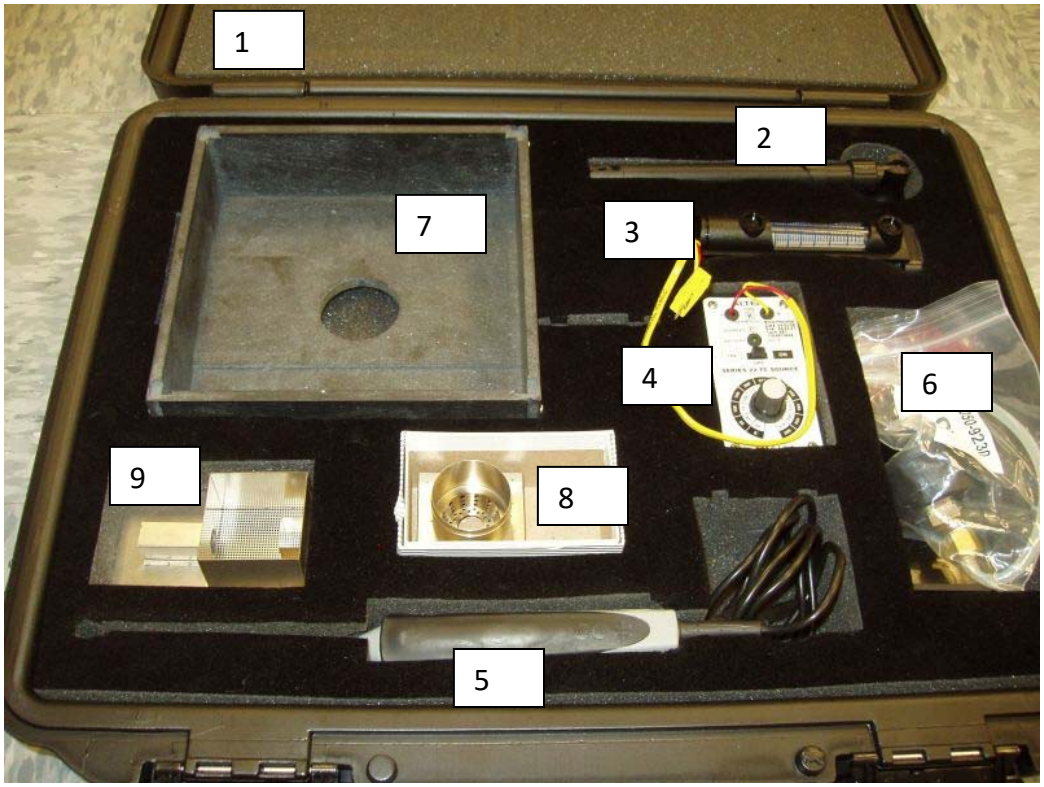
Description

The APR-CALKIT includes the instrumentation and fixtures necessary to set top and bottom airflow and perform thermal calibration procedures to factory standards for the APR-5000 and APR-5000-DZ rework machines.

Packaging

No.	Description
1	Hard Shell Carrying Case
2	Airflow Velocity Meter, Stick
3	Airflow Meter, Ball
4	Thermocouple (TC) Calibrator / Simulator, K-Type, Celsius
5	Thermal Probe and Handle (APR-5000)
6	Vacuum / Pressure Gauge
7	APR-5000 Thermal / Airflow Calibration Fixture with Stand-offs
8	NZA-490-490 Reflow Nozzle
9	Bottom Metal Airflow Fixture

For procedures and more information, please contact APR Customer Service at Service@APR-Rework.com



APR-5000 Thermal Calibration

Thermal Calibration for the APR-5000 serves two main purposes: for all machines to be set to a factory standard and for multiple machines to have the capability of running the same thermal profiles with similar results. It is important to realize that thermal calibration is not directly related to performance; a machine that is slightly out of calibration will still perform as expected if the profiles are created and run with the same machine; calibration is mainly to establish a baseline for top and bottom heating.

The steps for APR-5000 thermal calibration are performed in the following order:

1. Thermocouple (TC) calibration
2. Reflow head (top heater) airflow setting
3. Bottom pre-heater airflow setting
4. Bottom pre-heater thermal calibration
5. Reflow head (top heater) thermal calibration

Note: Airflow setting can be done in any order but all should be set before performing thermal calibrations. Thermal calibrations can be done in any order.

The **APR-CALKIT** contains the equipment necessary for the following procedures.

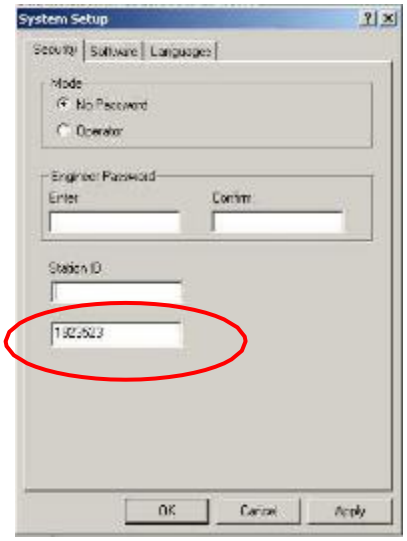
IMPORTANT: Thermal calibrations are only necessary if some of the critical parts to thermal performance have changed or been replaced, including main PCBA, heaters, RTD sensors, etc. If it is only needed to check machine thermal calibrations, run a verification plot then calibrate if necessary (out of tolerance).

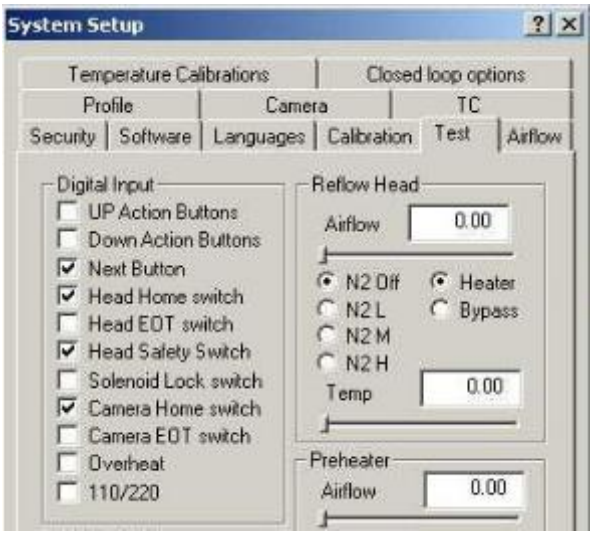
After any thermal calibration it may be necessary to make adjustments to existing part thermal profiles.

Section 1: Software Engineer's Window (Software versions 2.01.20 and earlier)

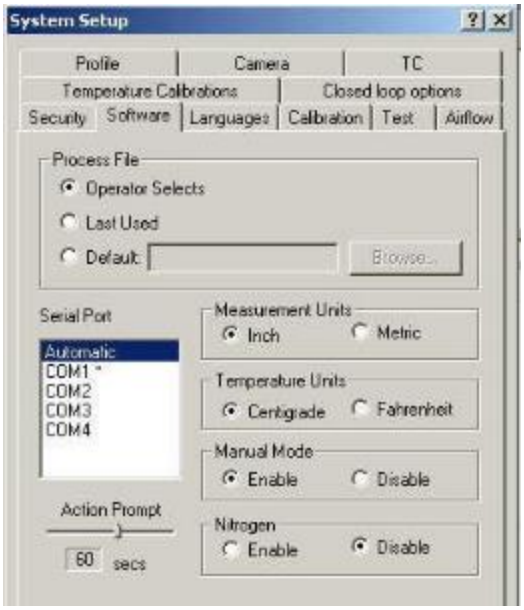
Most of the following procedures require using the engineer's password in System Setup to access control windows.

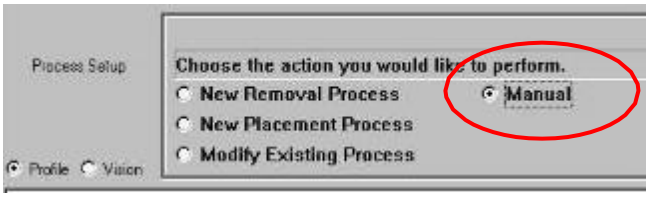
1. Click the System Setup button in the software.
2. Enter administrator password 1923523 in the bottom space for Station ID and click OK button.
3. Click System Setup button again. All the test and calibration tabs should now be visible.





4. Click the software tab and enable the manual mode, which will be used in several of the following procedures.

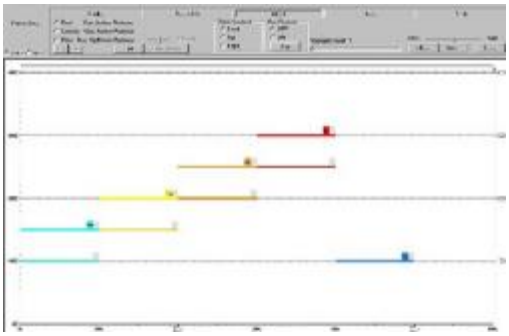




Section 2: System Warm-up

Before performing TC adjustments, thermal calibrations or verifications, the machine should be warmed up first.

1. Power on the APR-5000. Start the APR software.
2. In Process Setup select manual mode. Continue to the command window. Click start to run the default thermal profile and warm up the machine. The default profile is the one that is loaded when the software is first started.
3. After the machine has finished the complete cycle, click <next> to exit the manual mode and return to main screen.



Section 3: APR-5000 Thermocouple Calibration

***Required Equipment*:**
Altek or Omega Thermocouple (TC) simulator/calibrator, K-type

1. Power on the APR. Open software and run default profile in manual mode to warm up the machine (refer to Section 2).
2. Click System Setup and enter admin password 1923523 in the bottom space of the Station ID. Click OK. Re-enter System Setup. All setup tabs should now be seen (refer to Section 1).
3. Click on TC tab to enter thermocouple calibration window.
4. Connect the thermocouple simulator/calibrator to TC1 input.

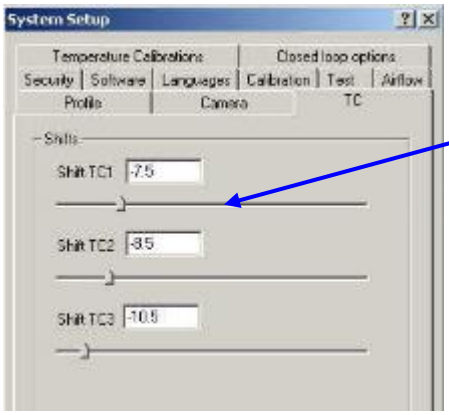
TC simulator/calibrator

TC1 – TC3 inputs

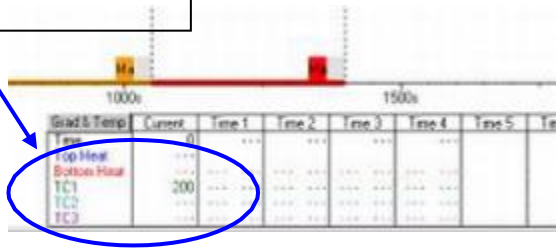
5. Switch TC simulator to ON position for the outer dark band.
6. Turn knob to 200°C. and observe TC1 reading at the bottom of the software screen.
7. Adjust TC1 shifts in the setup window to adjust software reading to match 200°C simulator input. Example: If TC1 in software reads 198 adjust TC1 shift slide bar up +2°. If TC1 reads 203 adjust TC1 shift slide bar -3°. Tolerance is ± 2°.
8. Continue by connecting TC simulator to TC2 and TC3 and adjust TC shifts to match 200°C as needed.
9. When complete, click APPLY and OK.

Note: TC readings will <u>not</u> update until APPLY and OK buttons are clicked.

10. Review updated TC1 – TC3 readings. If further adjustment needed, repeat previous steps.



Adjust TC shifts to offset so that software reading matches 200 input of TC simulator



Section 4: APR-5000 Reflow Head Airflow Settings

***Required Equipment*:**
NZA-490-490 reflow box nozzle
In-line reflow airflow meter

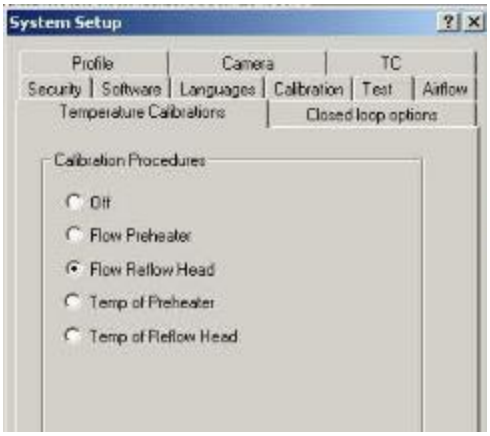
1. Power on APR-5000 unit and open the software.
2. Attach NZA-490-490 nozzle to the reflow head (no vacuum pipette)
3. Click System Setup and enter admin password 1923523 in the bottom space of the Station ID. Click OK and re-enter System Setup (see Section 1).
4. Click on Temperature Calibrations tab. Select **Flow Reflow Head**. Click OK. Follow the software prompts.
5. On the rear chassis panel, disconnect the white banded reflow air hose. Connect the hose from the in-line airflow meter (bottom) to the rear chassis white banded outlet. Connect the white banded hose going to the head to the top of the airflow meter. The input (bottom) to the meter will be coming from the machine and the output (top) will be going to the head.

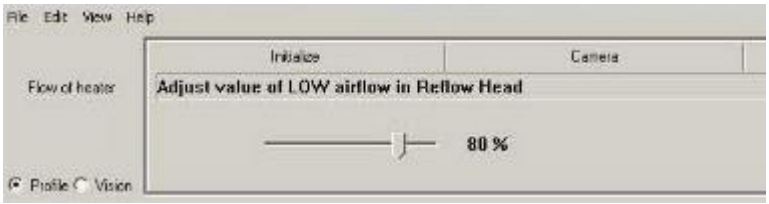
NOTE: make sure the flow meter is positioned straight up and down for accurate ball reading.

6. The factory reflow airflow settings for Low, Medium and High are as follows:

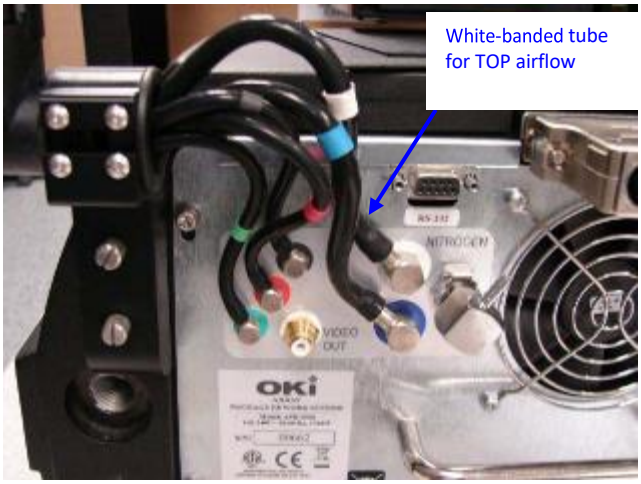
Reflow Head Airflow	Factory Setting
Low	**8 liters**
Medium	**16 liters**
High	**24 liters**

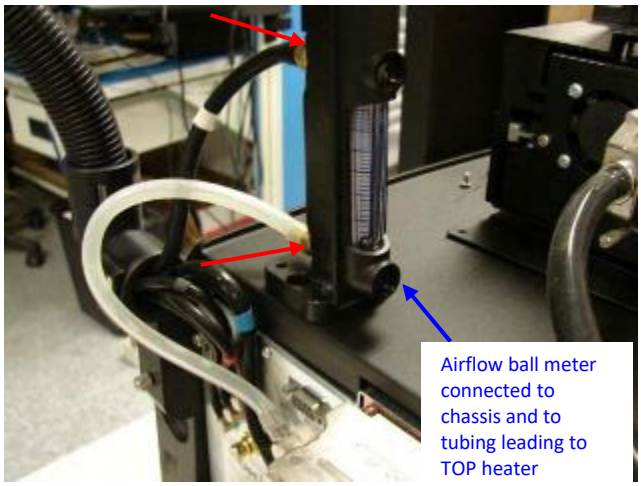
7. Read the meter by looking at the ball position and adjust Low, Medium and High airflow slider bars in the software procedure to set airflow to the factory settings. If already at setpoint, leave the slider as is and continue onward thru procedure.
8. Click FINISH to save settings and exit calibration window.





Software reflow TOP airflow adjustment

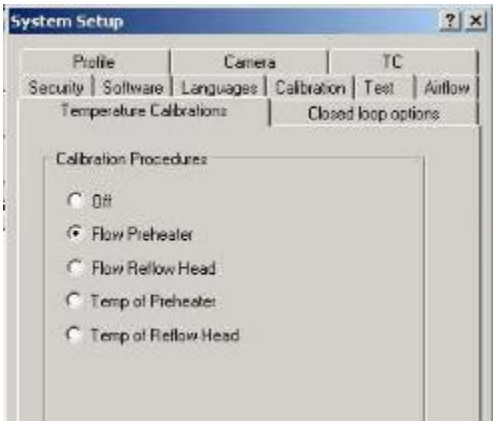


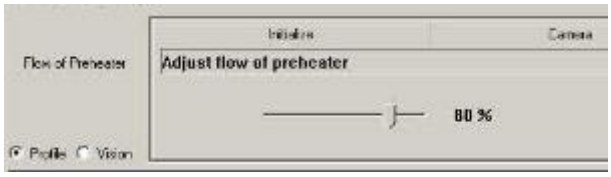


Section 5: APR-5000 Pre-heater Airflow Setting

Required Tools/Equipment:
APR-5000 thermal/airflow calibration box fixture
APR-5000 pre-heater metal airflow fixture
Pre-heater airflow meter

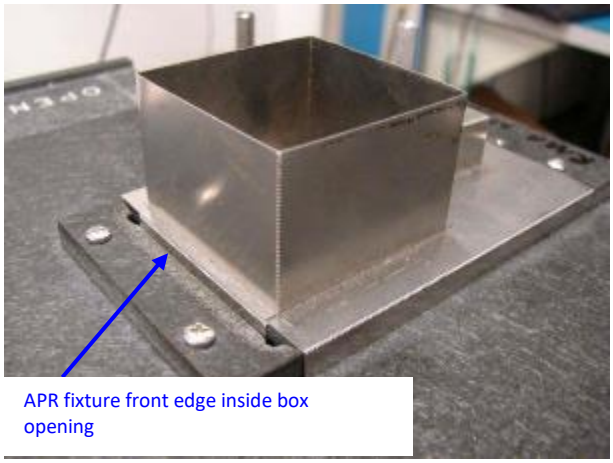
1. Power on APR-5000 and open software.
2. Click System Setup and enter admin password 1923523 in the bottom space of the Station ID. Click OK and re-enter System Setup (see Section 1).
3. Click on Temperature Calibrations tab. Select Flow Preheater and click OK.

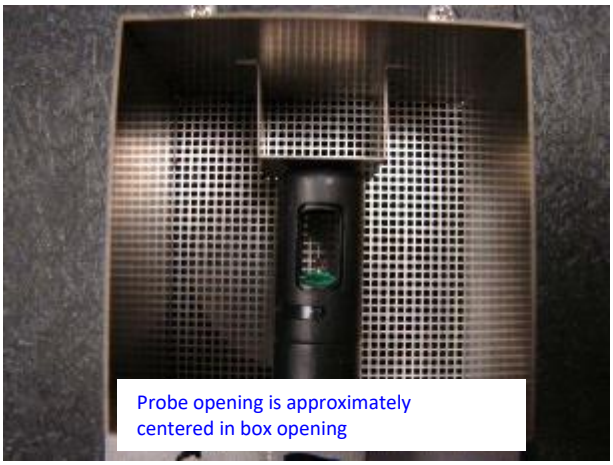




Software pre-heater airflow adjustment

4. At the software prompt, place the metal pre-heater airflow fixture onto the calibration box fixture as shown, with the front edge fitted inside the box opening.
5. Place the calibration box fixture onto the heater bowl grill as shown with the open side down. The pre-cut holes on the box fixture should fit over the grill screws and position the box. The center window should be OPEN for pre-heater airflow setting. Remove board holder rails if necessary to position box properly.





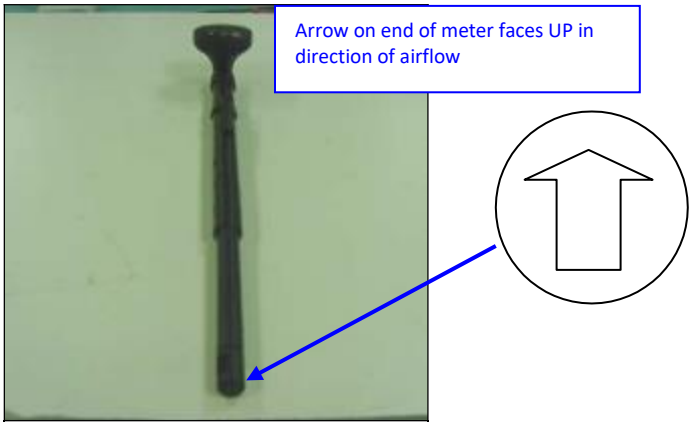
6. Unfold the pre-heater airflow meter as shown and insert the probe end into the slot on the metal fixture until it comes to a stop. Make sure that the arrow on the end of the meter is pointing UP (direction of flow). The metal fixture has a “stop” for the airflow meter so that the sensor ball is approximately in the center of the box circular window.

NOTE: very early metal airflow fixtures were made differently. If the sensor ball is too much off-center with the window then re-position the fixture with front edge over the top of box placement so that ball sensor is approximate center of window.

7. Turn on the airflow meter and set to read FT/MIN.
8. Continue in the software until the command “Adjust flow of preheater”.
9. The pre-heater airflow specification is:

APR-5000 Bottom Pre-heater Airflow Setting	
Air Flow Meter Reading	= 160 ft/min

10. Use the slider bar to adjust the airflow until the meter reads 160 ft/min.
11. Continue and select <finish> to save and complete pre-heater airflow setting.



Section 6: APR-5000 Pre-heater Thermal Calibration

***Required Equipment*:**
APR-5000 thermal/airflow calibration box fixture
APR-5000 thermal probe
NZA-490-490 reflow nozzle

NOTE: It is important to have consistent ambient conditions when running thermal calibrations. Conditions such as an air conditioner blowing downward directly onto the machine can cause inconsistent results; the machine should be located out of the influence of these areas.

The pre-heater thermal calibration process consists of running the auto-calibration (option for up to 3 cycles) in system setup first; then running a verification profile in the manual mode. If additional offset adjustments are needed, these will be done in system setup and will be followed by a verification run in the manual mode.

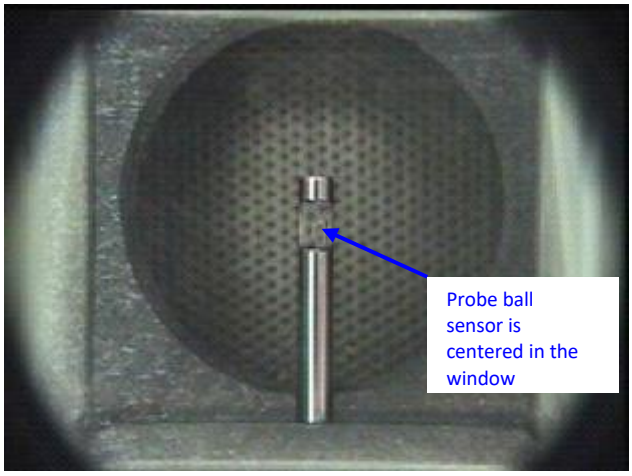
NOTE: If it is only needed to check existing thermal calibration then skip auto-calibration, set up fixtures and probe and run verification in manual mode. Auto-calibration will change settings when run.

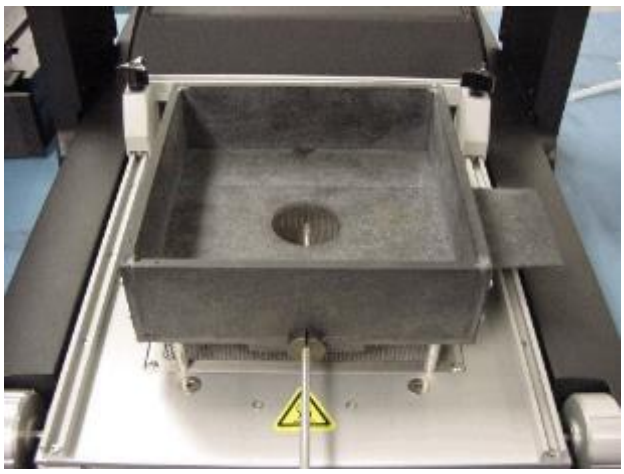
STEP 1: SYSTEM WARM-UP

1. Power on APR-5000 and open the software.
2. Run the default thermal profile to warm up the machine (Refer to Section 2).
3. After the machine has finished the cycle, click <next> to exit the manual mode and return to main screen.

STEP 2: SET-UP CALIBRATION FIXTURE

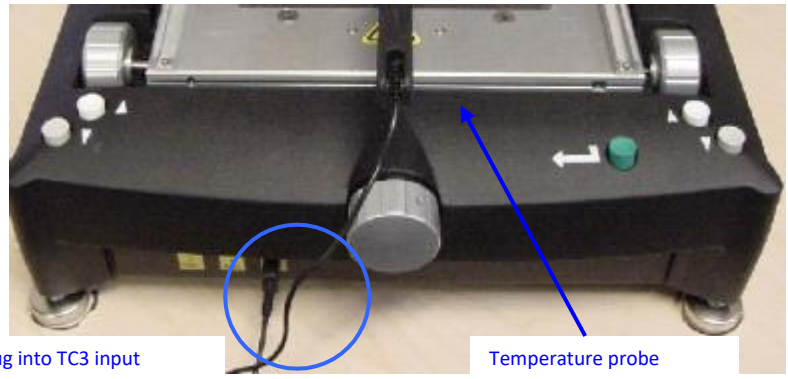
1. Attach NZA-490-490 nozzle onto the reflow head. Use the y-axis control to move the head to the rear and out of the way of the pre-heater area.
2. Insert the 8 standoffs into the thermal calibration box fixture from the APR-CALKIT.
3. Insert the thermal probe from the APR-CALKIT into the box fixture. Center the ball sensor of the probe (as seen inside the probe opening) in the circular opening of the box fixture. Use the thumbscrew to hold the probe in place (Do not overtighten!).





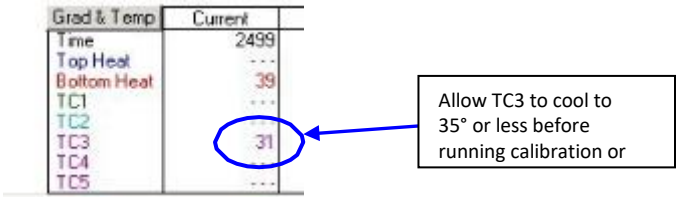
Position calibration box over the grill, open side UP

4. For the pre-heater thermal verification, the box fixture will be open end UP. Position the fixture so that the circular opening and probe are in the center of the grille. The standoffs should fit within the grille outer perimeter. The thermal probe handle should be facing frontward.
5. For the small pre-heater thermal calibration, the box fixture center window is OPEN.
6. Connect the thermal probe connector into TC3 on the front of the APR. TC3 is the only input that is used by the auto-calibration for feedback.

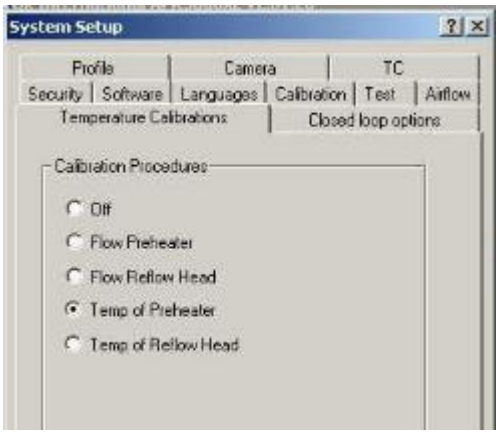


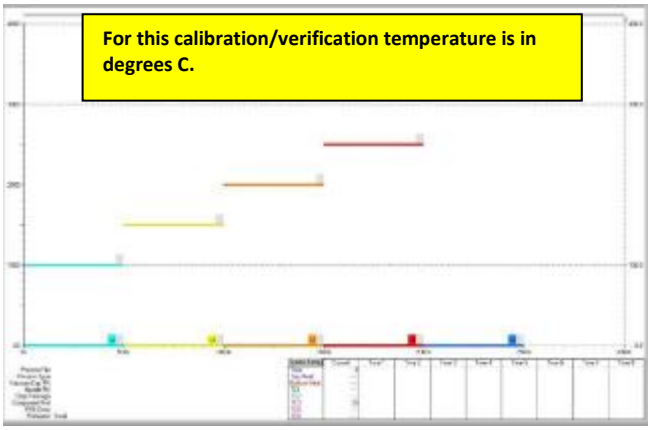
STEP 3: RUN AUTO-CALIBRATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



7. Click System Setup and enter admin password 1923523 into the bottom space of Station ID. Click OK and re-enter System Setup. All setup tabs should now be visible (see Section 1).
8. Click on Temperature Calibrations tab. Select Temp Pre-heater. Click OK.





9. Click <Start> and run the auto-calibration for one full cycle.

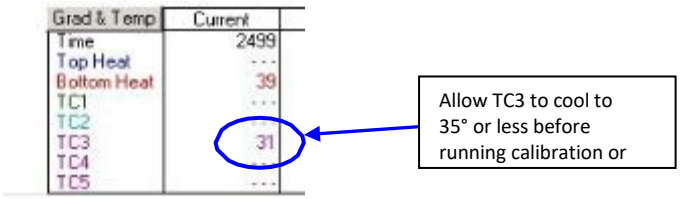
   IMPORTANT NOTE: while running the auto-calibration cycle, the profile plot on the screen will be changing continuously as the machine makes adjustments. This auto-calibration plot is NOT used to verify final thermal calibration. The verification is done in manual mode afterward.

10. The software is set up to run 3 auto-calibration cycles in a row. After the 1st cycle, continue following the software prompts and run the next 2 auto-calibration cycles (optional).
11. After completion of auto-calibration cycles, select <Finish> to save and exit the software calibration window.

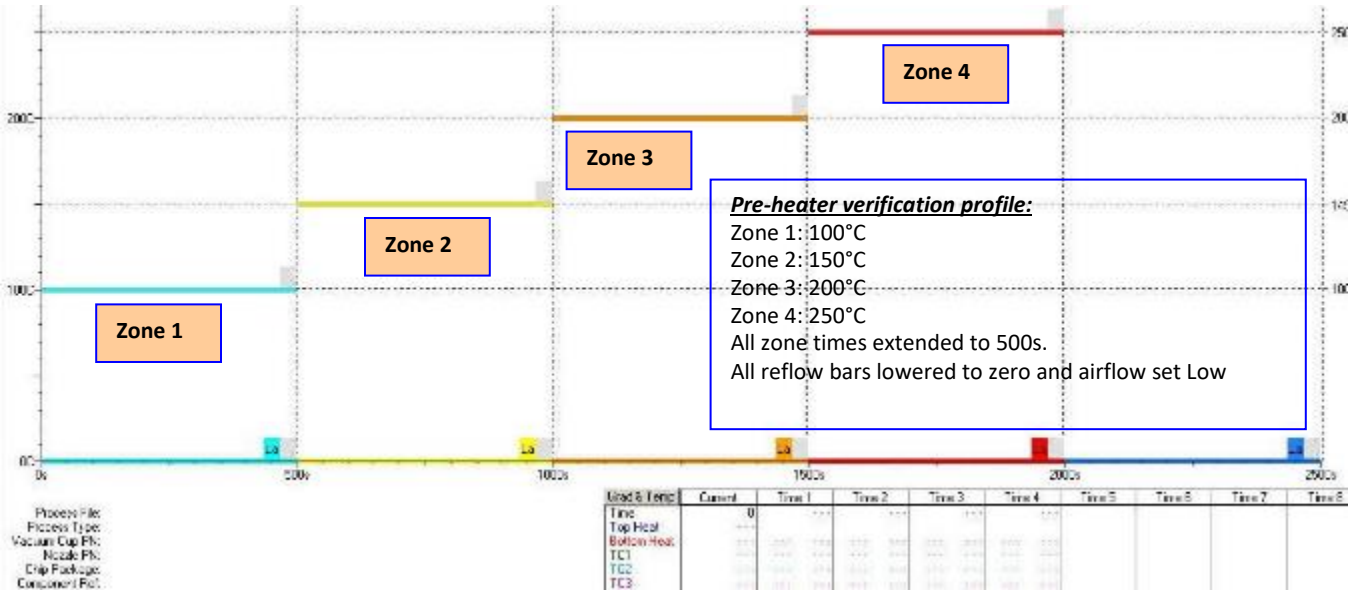
STEP 4: THERMAL VERIFICATION

1. To verify the pre-heater thermal calibration, click <Process Setup> and select the manual mode. Keep the thermal fixture and probe in the same position. Continue to the manual mode command window.
2. Keep the default pre-heater thermal profile settings: Zones 1-4 temperature bars are set at 100º; 150º; 200º; 250º C. Lower all reflow (top) heater temperature bars to zero and set airflow to low. Extend the time intervals for all zones to 500s each.

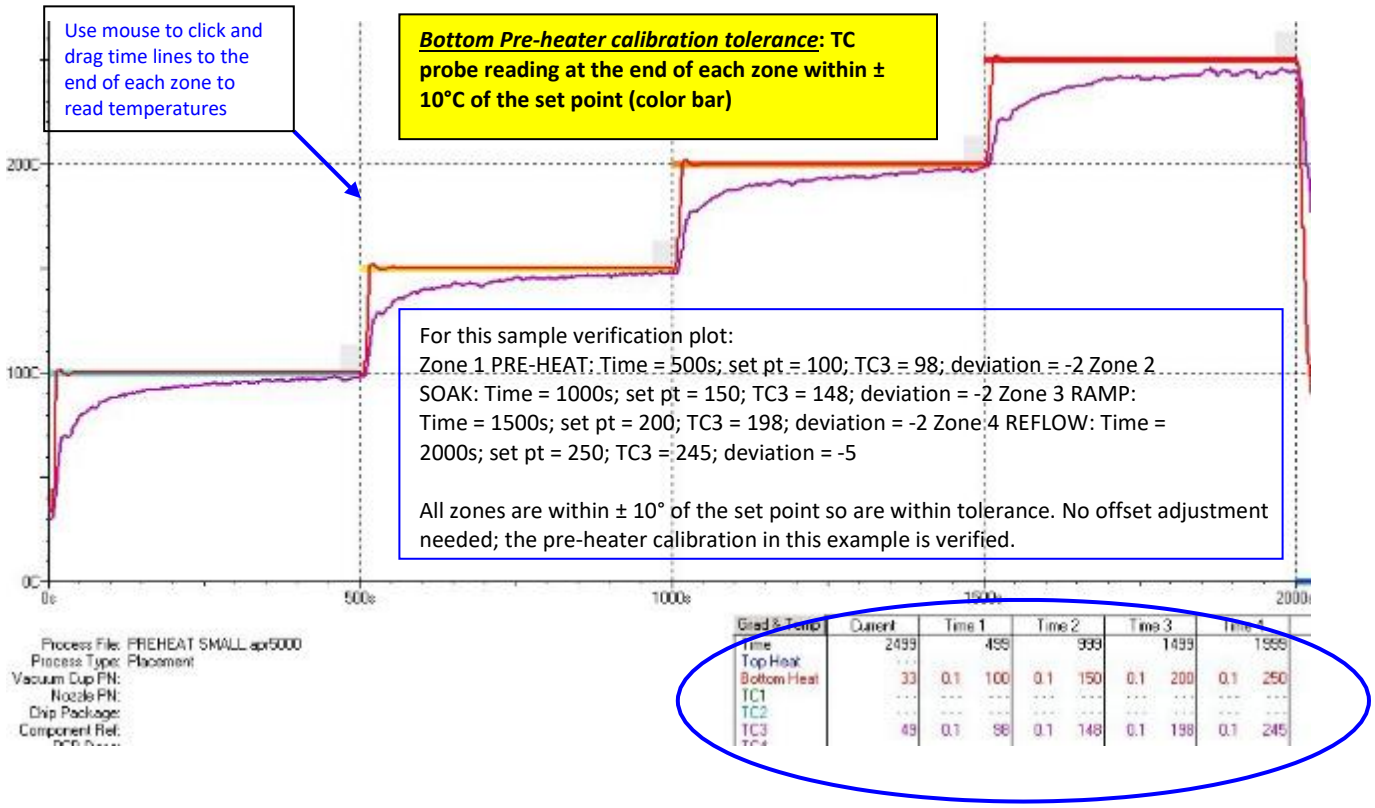
   NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



3. Click <start> to run the verification profile.



4. After the complete cycle finishes, review the TC 3 plot temperature (from the probe) at the end of each zone. Position the time lines at the end of each zone so that the exact TC 3 temperature can be reviewed at the bottom of the software screen: Time 1, Time 2, Time 3, Time 4.
5. For all 4 heat zones, record the temperature deviation from the set points (bottom heater color bars). Example: The 1st zone set point color bar is 100º C. If the TC 3 reading at the end of this zone is 85º C, record the 1st zone deviation as - 15º C. If the TC plot at the end of the zone is 137º C, then the deviation is + 37º C.
6. <u>If the TC readings at the end of each zone are all within **± 10º C** of the set point, the bottom heater calibration is verified</u>. Go to Step 5 to adjust thermal offsets only if any of the zones are outside of this tolerance.



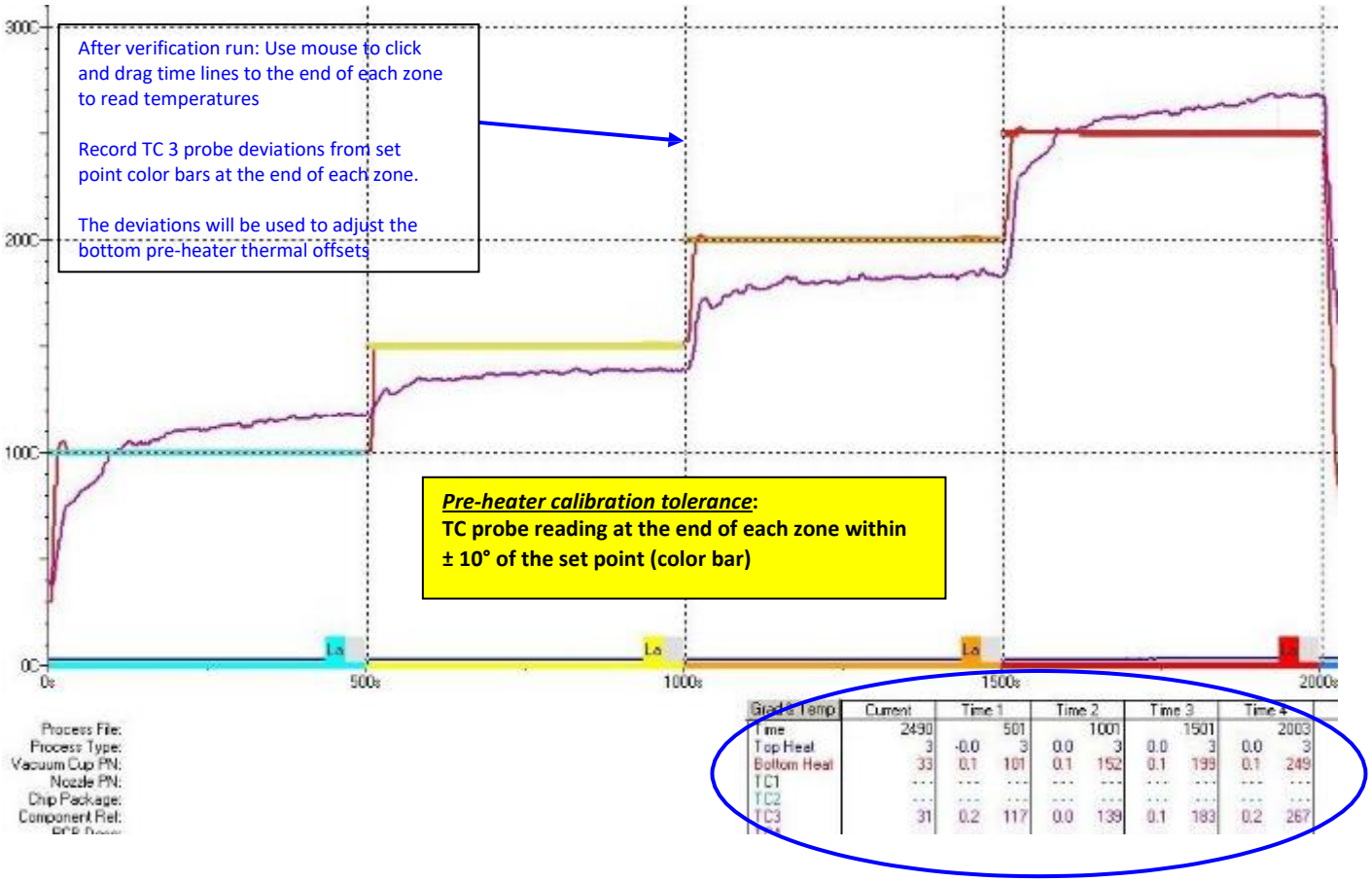
STEP 5: OFFSET ADJUSTMENT

1. The thermal offsets can be adjusted if any of the 4 zones in the verification run do not fall within ± 10° of the pre-heater set points. The offset adjustments are based on the TC3 deviations from the set points, which were recorded in Step 4, and will be used to try to bring in the probe temperature at the end of each zone to within tolerance of the set point color bars.
2. Exit the manual mode, click System Setup and enter admin password 1923523 into the bottom space of Station ID. Click OK and re-enter System Setup. All setup tabs should now be visible (refer to Section 1).

3. Select the <Profile> tab. The thermal offsets for each for the 4 zones for the small pre-heater are the 4 settings under **Bottom Heat Zone**.
4. The thermal offsets may not be necessarily linear, or one-to-one, but the first offset adjustments will be made one-to-one and a 2nd verification run to see to the effect.

   Example: Zone 1 set point color bar is 100°. The TC 3 reading for the 1st verification run at the end of zone 1 was 117°. The deviation is 117 - 100 = + 17°.

   If reflow zone offset is set at 45°, the 1st adjustment should 45 – 17 = 28, or the one-to-one amount of the deviation. If the offset does not happen to be one-to-one, this will be seen in the 2nd verification run. For example, if we expected zone 1 to now be at 100° but it turned out to be 83°, or double the effect of what was expected. In that case we would assume offset if roughly 1 to 2 and adjust according for 3rd run.



Graph Temp	Current	Time 1		Time 2		Time 3		Time 4	
Time	2490		501		1001		1501		2003
Top Heat	3	-0.0	3	0.0	3	0.0	3	0.0	3
Bottom Heat	33	0.1	101	0.1	152	0.1	199	0.1	249
TC1	---	---	---	---	---	---	---	---	---
TC2	---	---	---	---	---	---	---	---	---
TC3	31	0.2	117	0.0	139	0.1	183	0.2	267

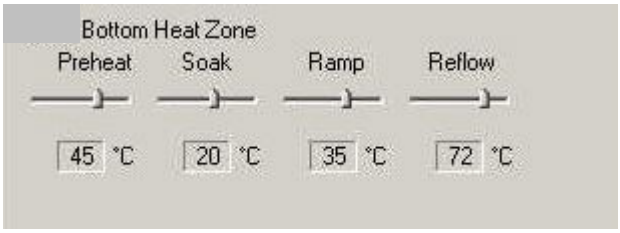
For this sample verification plot
Zone 1 PRE-HEAT: Time = 500s; set pt = 100; TC3 = 117; deviation = +17 Zone 2 SOAK: Time = 1000s; set pt = 150; TC3 = 139; deviation = - 11 Zone 3 RAMP: Time = 1500s; set pt = 200; TC3 = 183; deviation = - 17 Zone 4 REFLOW: Time = 2000s; set pt = 250; TC3 = 267; deviation = +17

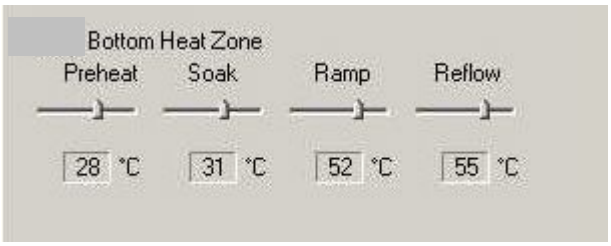
TC3 at the end of all zones is outside of the ± 10° of the set points so the offsets for all zones will need adjustment and the verification profile run again

5. Using the recorded TC deviations, adjust the offsets in each of the 4 zones if out of the ± 10° C tolerance.

Pre-heater offsets BEFORE 1st ADJUSTMENT Deviations from 1st verification plot:
Zone 1 = + 17
Zone 2 = - 11
Zone 3 = - 17
Zone 4 = + 17

Pre-heater offsets AFTER 1st adjustment:
Zone 1: 45 – 17 = 28
Zone 2: 20 + 11 = 31
Zone 3: 35 + 17 = 52
Zone 4: 72 – 17 = 55



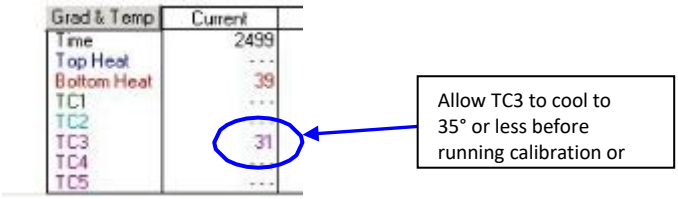


6. After making the offset adjustments, click <APPLY>, then <OK>.

The changes to the offsets will not be saved unless this is done

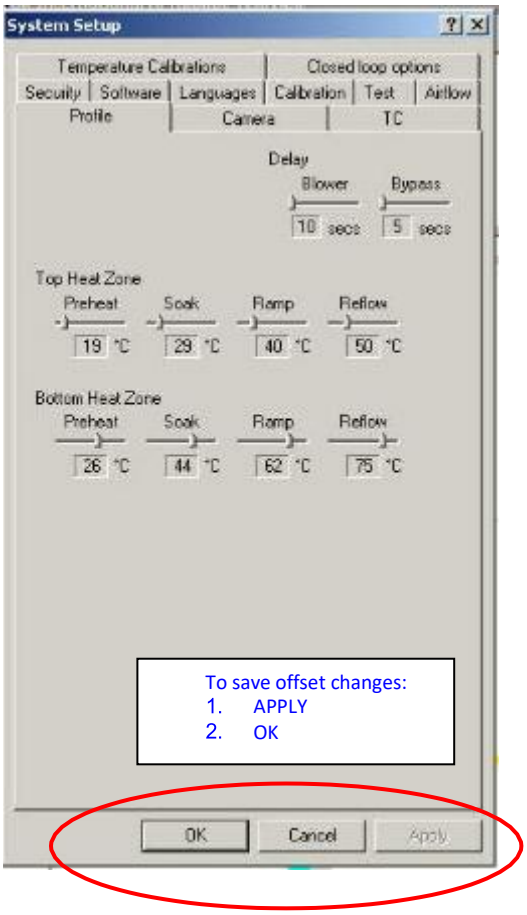
7. In the manual mode, run the 2nd bottom pre-heater verification.

   Make sure the TC3 probe reading is cooled down to ≤ 35º C before starting the cycle again.



8. For 2nd run, review all deviations between set point and TC 3 readings at the end of each zone. If all 4 zones are within the ± 10º C tolerance of TC 3 probe to set point color bar then bottom pre-heater has been verified and calibrated.

   If further offset adjustments are necessary, repeat above procedure for Step 5 until bottom pre-heater is calibrated and verified.



Section 8: APR-5000 Reflow Head (Top Heater) Thermal Calibration

***Required Equipment*:**
APR-5000 thermal/airflow calibration box fixture
APR-5000 thermal probe
NZA-490-490 reflow nozzle

NOTE: It is important to have consistent ambient conditions when running thermal calibrations. Conditions such as an air conditioner blowing downward directly onto the machine can cause inconsistent results; the machine should be located out of the influence of these areas.

The reflow thermal calibration process consists of running the auto-calibration (option for up to 3 cycles) in system setup first; then running a verification profile in the manual mode. If additional offset adjustments are needed, these will be done in system setup and will be followed by a verification run in the manual mode.

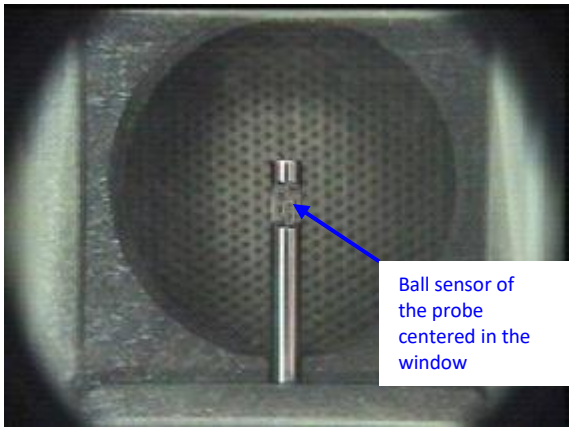
NOTE: If it is only needed to check existing thermal calibration then skip auto-calibration, set up fixtures and probe and run verification in manual mode. Auto-calibration will change settings when run.

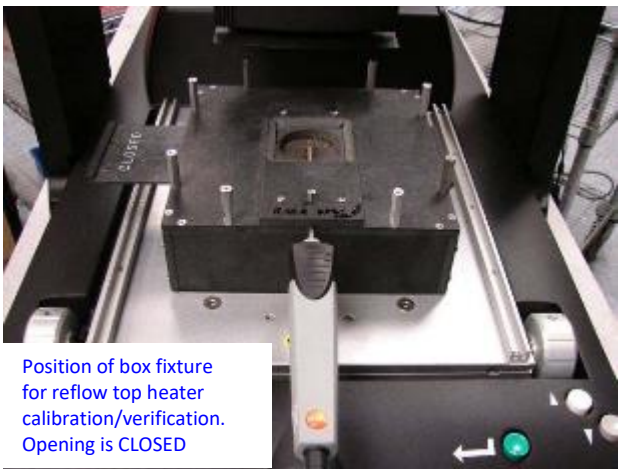
STEP 1: SYSTEM WARM-UP

1. Power on APR-5000 and open the software.
2. Run the default thermal profile to warm up the machine (Refer to Section 2).
3. After the machine has finished the cycle, click <next> to exit the manual mode and return to main screen.

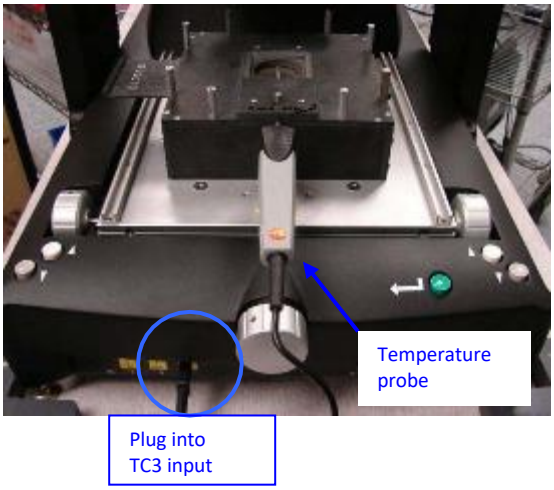
STEP 2: SET UP CALIBRATION FIXTURE

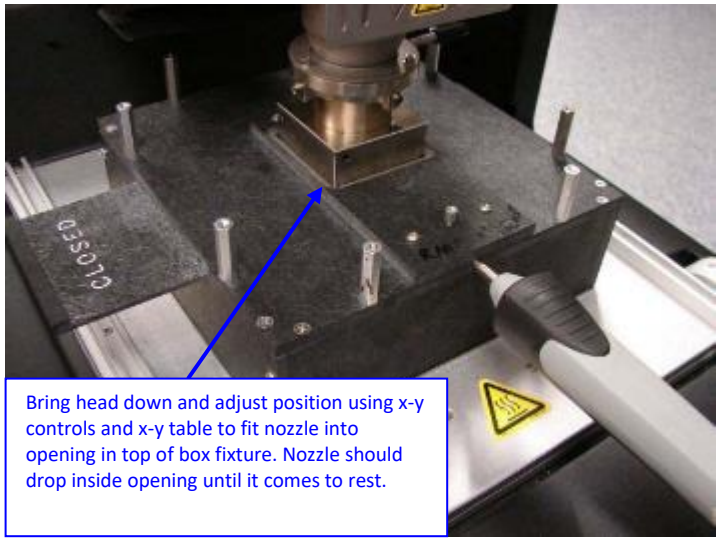
1. Attach NZA-490-490 nozzle onto the reflow head.
2. Insert the 8 standoffs into the thermal calibration box fixture from the APR-CALKIT.
3. Insert the thermal probe from the APR-CALKIT into the box fixture. Center the ball sensor of the probe (inside the probe opening) in the circular opening of the box fixture. Use the thumbscrew to hold the probe in place (Do not overtighten!).
4. For the reflow top heater thermal calibration or verification the box fixture will be open end DOWN. Place the calibration box fixture onto the heater bowl grill. The pre-cut holes on the box fixture should fit over the grill screws and position the box. The thermal probe handle should be facing frontward. Remove board holder rails if necessary to position box properly.





5. For the small pre-heater thermal calibration, the box fixture center window is CLOSED.
6. Connect the thermal probe connector into TC3 on the front of the APR. TC3 is the only input that is used by the auto-calibration for feedback.

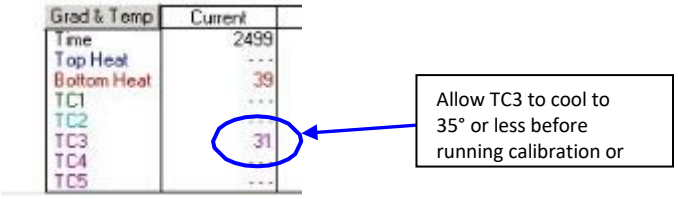




7. For auto-calibration, NZA-490-490 reflow head nozzle will be positioned into the top of box fixture as shown during the software setup procedure for calibration run (see next section) using z-axis control buttons to bring down the head and aligning nozzle into box opening by x and y gantry adjustment and x-y table. For thermal verification, reflow head nozzle will be positioned into the top of box fixture in the manual mode using same controls. In both cases the reflow nozzle should drop inside opening until it comes to rest.

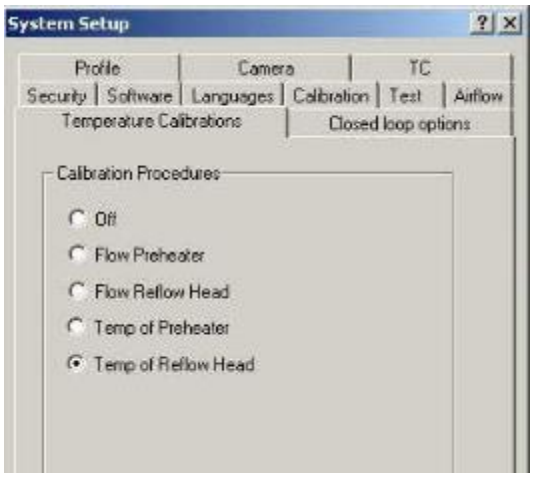
STEP 3: AUTO-CALIBRATION

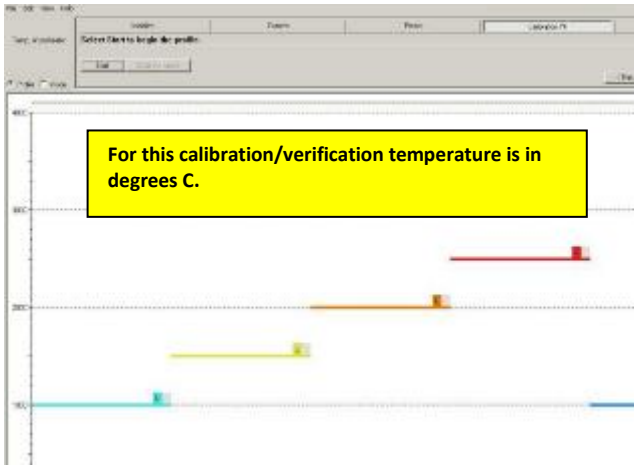
NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



1. Click System Setup and enter admin password 1923523 into the bottom space of Station ID. Click OK and re-enter System Setup.
2. Click on Temperature Calibrations tab. Select Temp of Reflow Head. Click OK.
3. Follow software prompts including setup of calibration fixture as in Step 2.
4. Use the x and y buttons to move the head position so that the NZA-490-490 nozzle is roughly aligned with the opening on top of the box fixture.

5. Bring the head down and align NZA-490-490 nozzle so that it drops down into the opening on top of the box fixture. Use the x-y table fine adjustment until the nozzle drops inside the opening and comes to rest.

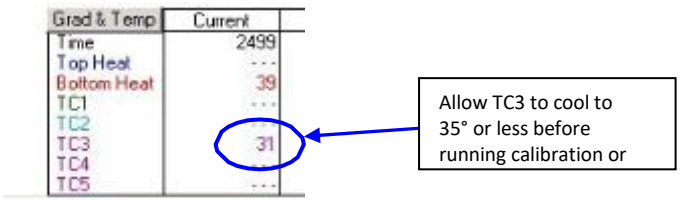




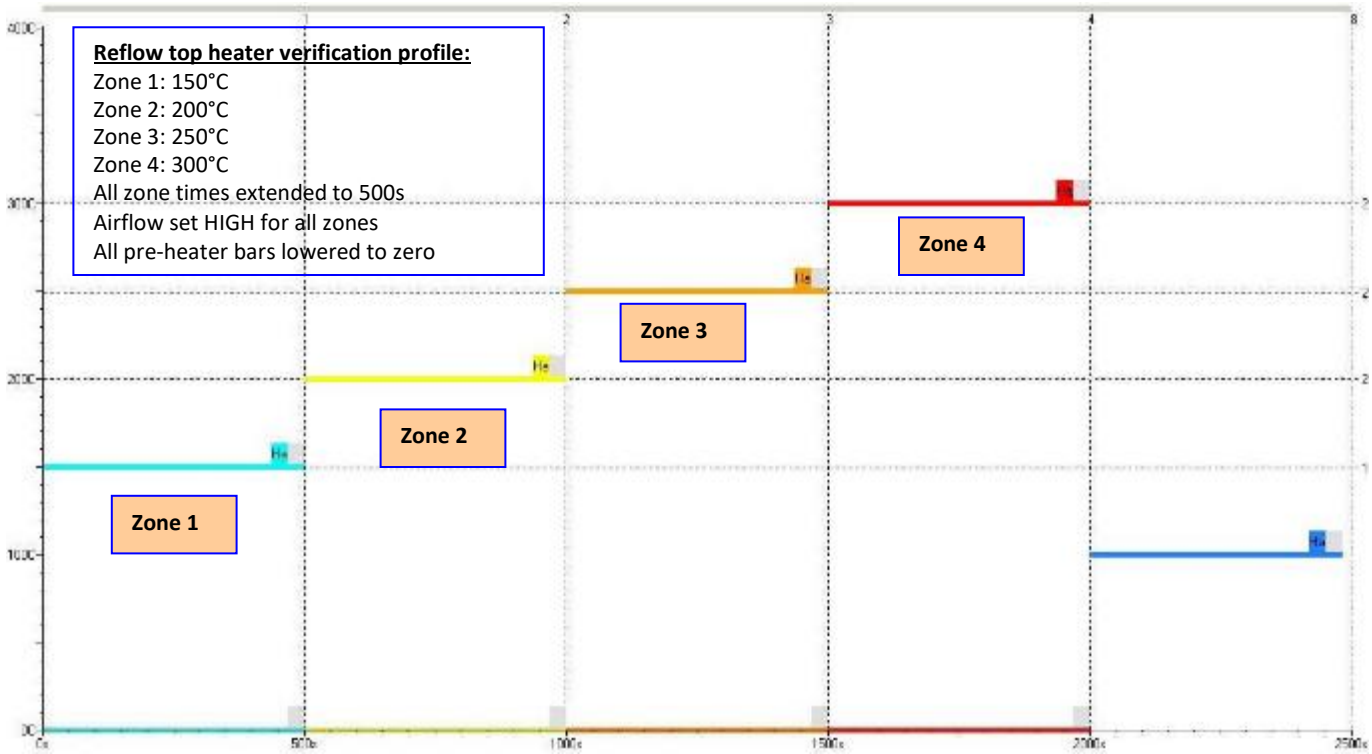
6. Click <Start> and run the auto-calibration for one full cycle.
   IMPORTANT NOTE: while running the auto-calibration cycle, the profile plot on the screen will be changing continuously as the machine makes adjustments. This auto-calibration plot is NOT used to verify final thermal calibration. The verification is done in manual mode afterward.
7. The software is set up to run 3 auto-calibration cycles in a row. After the 1st cycle, continue following the software prompts and run the next 2 auto-calibration cycles (optional).
8. After completion of auto-calibration cycles, select <Finish> to save and exit the software calibration window.

STEP 4: THERMAL VERIFICATION

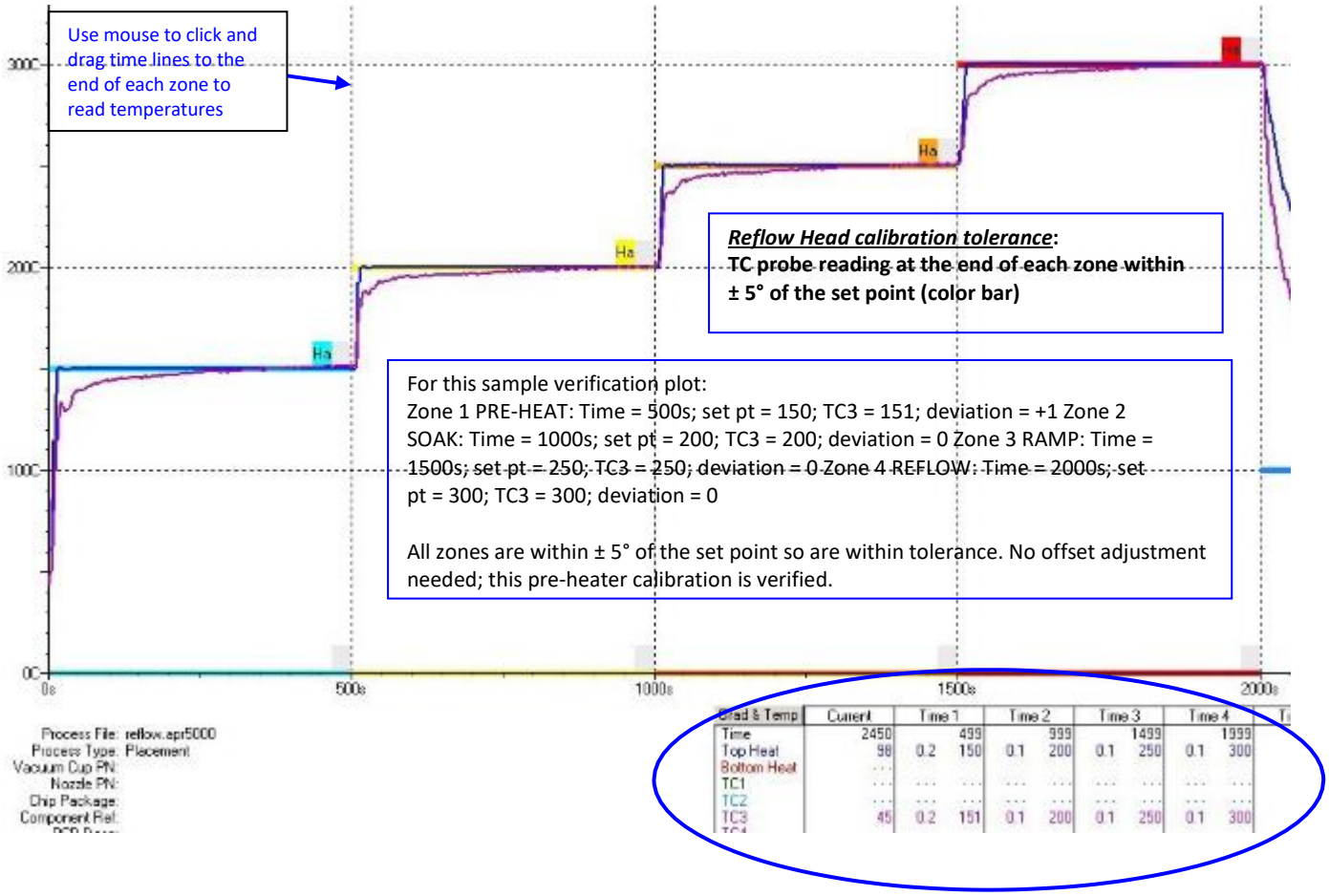
1. To verify the pre-heater thermal calibration, click <Process Setup> and select the manual mode. Keep the thermal fixture and probe in the same position. Continue to the manual mode command window.
2. Keep the default top heater thermal profile settings: Zones 1-4 temperature bars are set at 150º; 200º; 250º; 300º C. Set airflow for all zones to HIGH. Lower all bottom pre-heater temperature bars to zero. Extend the time intervals for all zones to 500s each.
   NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



3. Click <start> to run the verification profile.



4. After the complete cycle finishes, review the TC 3 plot temperature (from the probe) at the end of each zone. Position the time lines at the end of each zone so that the exact TC 3 temperature can be reviewed at the bottom of the software screen: Time 1, Time 2, Time 3, Time 4.
5. For all 4 heat zones, record the temperature deviation from the set points (top heater color bars). Example: The 1st zone set point color bar is 150º C. If the TC 3 reading at the end of this zone is 157º C, record the 1st zone deviation as + 7º C. If the TC plot at the end of the zone is 143º C, then the deviation is - 7º C.
   <u>If the TC readings at the end of each zone are all within **± 5º C** of the set point, the top heater calibration is verified</u>. Go to Step 5 to adjust thermal offsets only if any of the zones are outside of this tolerance.



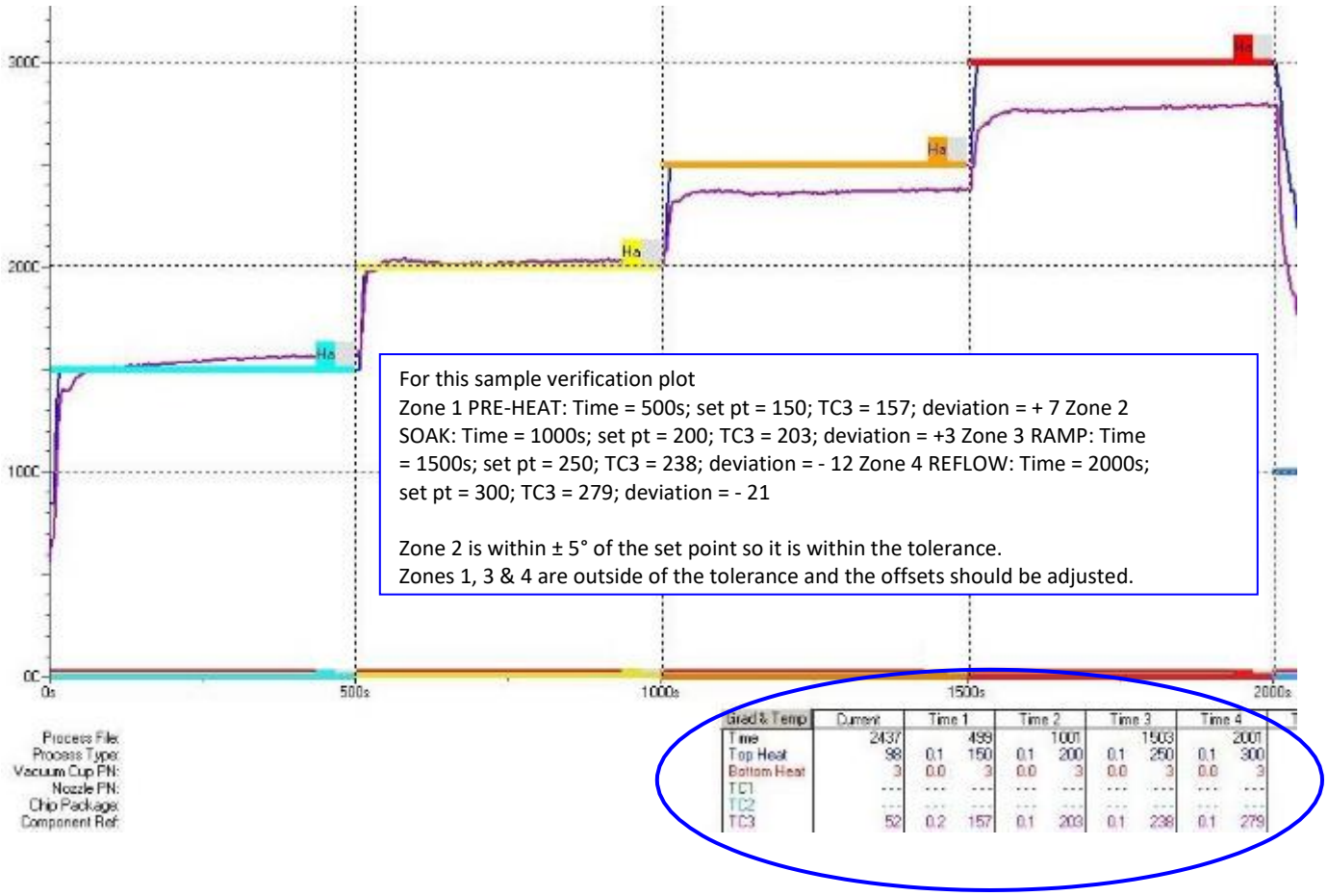
STEP 5: OFFSET ADJUSTMENT

1. The thermal offsets can be adjusted if any of the 4 zones in the verification run do not fall within ± 5° of the top heater set points. The offset adjustments are based on the TC3 deviations from the set points, which were recorded in Step 4, and will be used to try to bring in the probe temperature at the end of each zone to within tolerance of the set point color bars.
2. it the manual mode, click System Setup and enter admin password 1923523 into the bottom space of Station ID. Click OK and re-enter System Setup. All setup tabs should now be visible (refer to Section 1).
3. Select the <Profile> tab. The thermal offsets for each for the 4 zones for the small pre-heater are the 4 settings under **Top Heat Zone**.
4. The thermal offsets may not be necessarily linear, or one-to-one, but the first offset adjustments will be made one-to-one and a 2nd verification run to see to the effect.

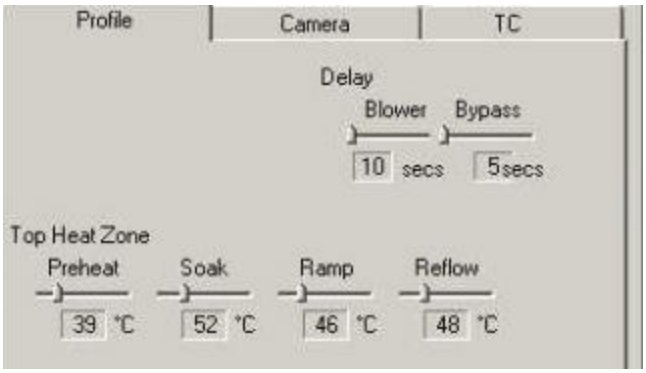
   Example: Zone 1 set point color bar is 150°. The TC 3 reading for the 1st verification run at the end of zone 1 was 157°. The deviation is 157 - 150 = + 7°.

   If reflow zone offset is set at 39°, the 1st adjustment should 39 – 7 = 32, or the one-to-one amount of the deviation.

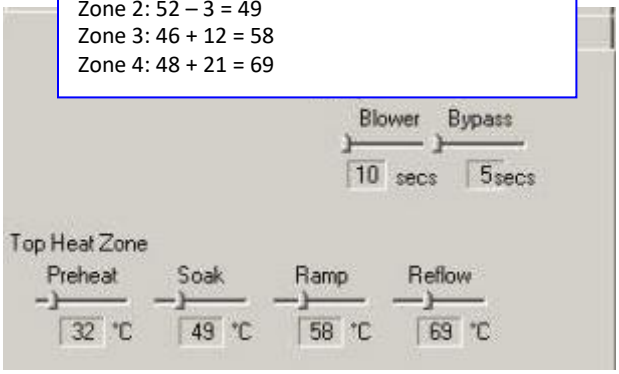
If the offset does not happen to be one-to-one, this will be seen in the 2nd verification run. For example, if we expected zone 1 to now be at 150° but it turned out to be 143°, or double the effect of what was expected. In that case we would assume offset if roughly 1 to 2 and adjust according for 3rd run.



Top heater offsets BEFORE 1st ADJUSTMENT:



Top heater offsets AFTER 1st adjustment: Zone 1: 39 – 7 = 32
Zone 2: 52 – 3 = 49
Zone 3: 46 + 12 = 58
Zone 4: 48 + 21 = 69

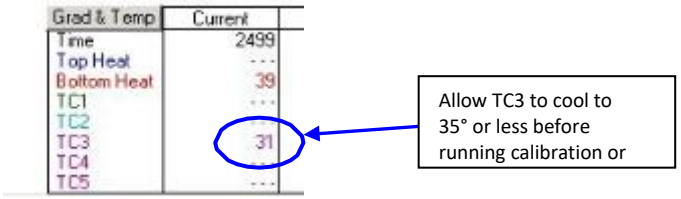


5. After making the offset adjustments, click <APPLY>, then <OK>.

The changes to the offsets will not be saved unless this is done

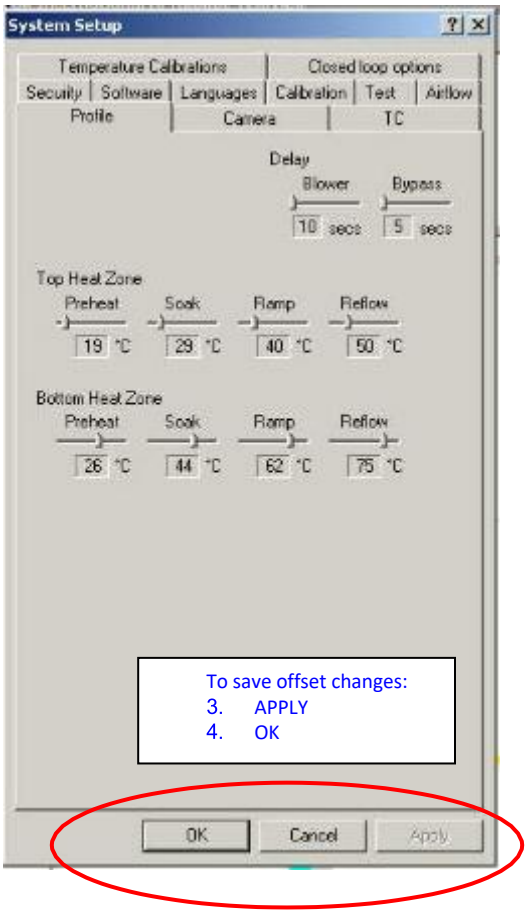
6. In the manual mode, run the 2nd top heater verification.

   Make sure the TC3 probe reading is cooled down to ≤ 35º C before starting the cycle again.



7. For 2nd run, review all deviations between set point and TC 3 readings at the end of each zone. If all 4 zones are within the ± 5º C tolerance of TC 3 probe to set point color bar then top heater has been verified and calibrated.

   If further offset adjustments are necessary, repeat above procedure for Step 5 until top heater is calibrated and verified.



Summary:

The top and bottom heaters have now been calibrated to factory standards.

The thermal offsets are saved in memory on the machine's control PCBA and not the software.

A record of all the thermal offsets should be saved for future reference by doing a print screen of the profile tab (see above) and pasting into a new picture or WordPad document.

APR-5000-DZ Thermal Calibration

The following procedures are intended as supplemental to the APR-5000-DZ Calibration Manual.

Thermal Calibration for the APR-5000-DZ serves two main purposes: for all machines to be set to a factory standard and for multiple machines to have the capability of running the same thermal profiles with similar results. It is important to realize that thermal calibration is not directly related to performance; a machine that is slightly out of calibration will still perform as expected if the profiles are created and run with the same machine; calibration is mainly to establish a baseline for top and bottom heating.

The steps for APR-5000 thermal calibration are performed in the following order:

1. Thermocouple (TC) calibration
2. Reflow head (top heater) airflow setting
3. Bottom pre-heater airflow setting (large & small)
4. Bottom pre-heater thermal calibration (large & small)
5. Reflow head (top heater) thermal calibration

Note: Airflow setting can be done in any order but all should be set before performing thermal calibrations. Thermal calibrations can be done in any order.

The **APR-CALKIT** contains the equipment necessary for the following procedures.

IMPORTANT: Thermal calibrations are normally only necessary if some of the critical parts to thermal performance have changed or been replaced, including main PCBA, heaters, RTD sensors, etc. If it is only needed to check machine thermal calibrations, run a verification plot then calibrate if necessary (out of tolerance).

After any thermal calibration it may be necessary to make adjustments to existing thermal profiles.

- The following procedures will require the software admin mode or password. Refer to appendix 1.
- The following procedures will require enable and use of the manual mode. Refer to appendix 2.

Section 1: System Warm-up

Before performing TC adjustments, thermal calibrations or verifications, the machine should be warmed up first.

1. Power on the APR-5000-DZ. Open the APR software.
2. In Process Setup select manual mode. Continue to the command window. Click start to run the default stair-step thermal profile and warm up the machine. The default profile is the one that is loaded when the software is first started.
3. After the machine has finished the complete cycle, click <next> to exit the manual mode and return to main screen

Section 2: APR-5000-DZ TC1,2,3 Thermocouple Calibration

Required Equipment:
Altek or Omega Thermocouple (TC) simulator/calibrator, K-type

1. Power on the APR. Open software and run default profile in manual mode to warm up the machine (refer to Section 2).
2. In admin mode (refer to appendix) enter System Setup menu. Click on TC tab to enter thermocouple calibration window.
3. Connect the thermocouple simulator/calibrator to TC1 input.

TC simulator/calibrator

TC1 – TC3 inputs

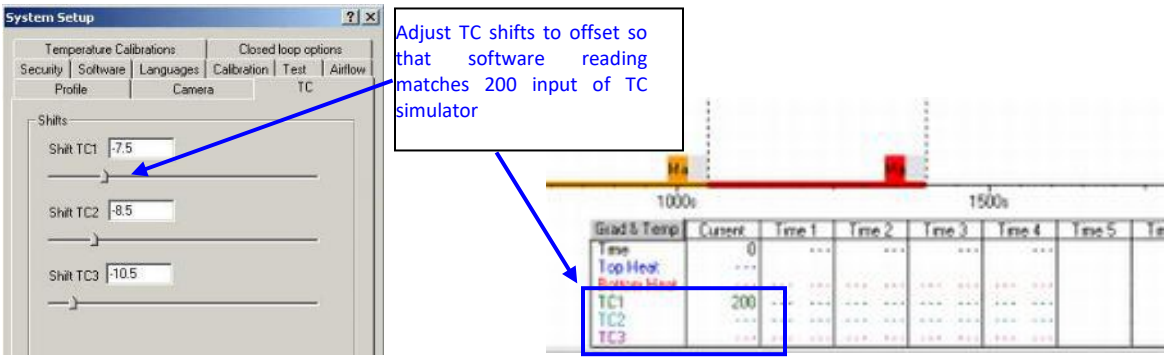
4. Switch TC simulator to ON position for the outer dark band.
5. Turn knob to 200°C. and observe TC1 reading at the bottom of the software screen.
6. Use the slider to adjust TC1 shifts in the setup window to adjust software reading to match 200°C simulator input. Example: If TC1 in software reads 198 adjust TC1 shift slide bar up +2°. If TC1 reads 203 adjust TC1 shift slide bar -3°. Tolerance is ± 2°.

NOTE: TC shifts may not be one-to-one and may require some additional adjustment.

7. Continue by connecting TC simulator to TC2 and TC3 and adjust TC shifts to match 200°C as needed.
8. When complete, click APPLY and OK.

Note: TC readings will <u>not</u> update until APPLY and OK buttons are clicked.

9. Review updated TC1 – TC3 readings. If further adjustment needed, repeat previous steps.



Section 3: APR-5000-DZ Reflow Head Airflow Settings

Required Equipment:
NZA-490-490 reflow box nozzle In-line reflow airflow meter

1. Power on APR-5000 unit and open the software.
2. Attach NZA-490-490 nozzle to the reflow head (no vacuum pipette)
3. In admin mode (refer to appendix) enter System Setup menu.
4. Click on Temperature Calibrations tab. Select **Flow Reflow Head**. Click OK. Follow the software prompts.
5. On the rear chassis panel, disconnect the white banded reflow air hose. Connect the hose from the in-line airflow meter (bottom) to the rear chassis white banded outlet. Connect the white banded hose going to the head to the top of the airflow meter. The input (bottom) to the meter will be coming from the machine and the output (top) will be going to the head.

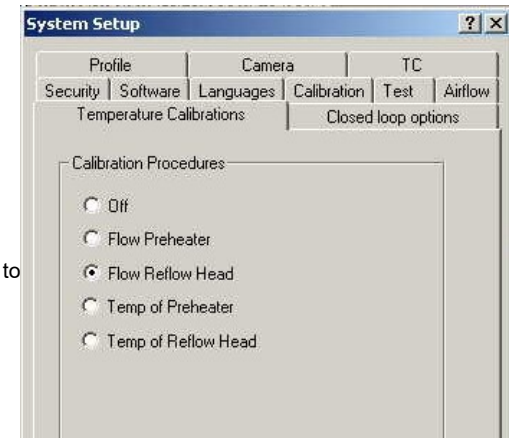
NOTE: make sure the flow meter is positioned straight up and down for accurate ball reading.

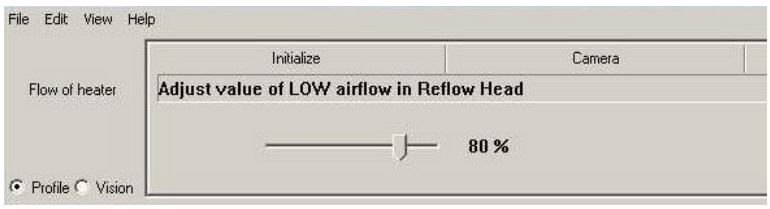
6. The factory reflow airflow settings for Low, Medium and High are as follows:

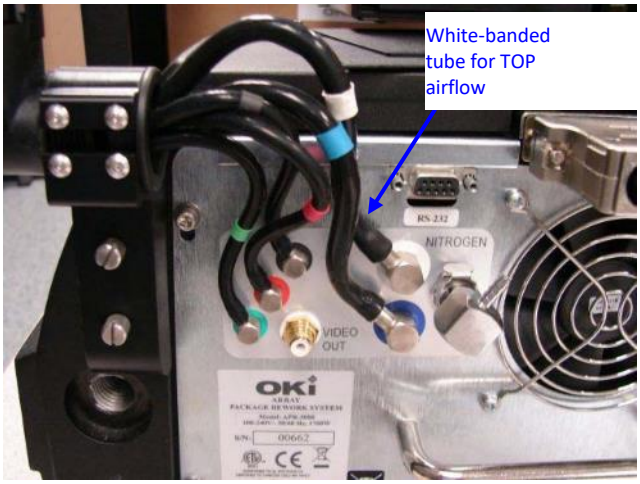
Reflow Head Airflow	Factory Setting
Low	**8 liters**
Medium	**16 liters**
High	**22 liters**

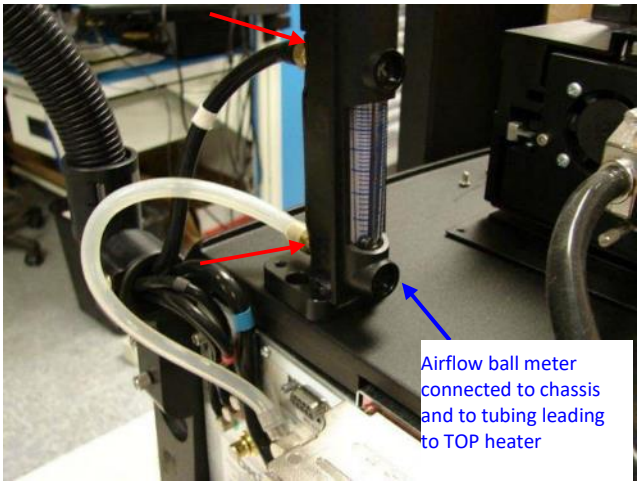
7. Read the meter by looking at the ball position and adjust Low, Medium and High airflow slider bars in the software procedure to set airflow to the factory settings. If already at setpoint, leave the slider as is and continue onward thru procedure.
8. Click FINISH to save settings and exit calibration window.

Software reflow TOP airflow adjustment









Section 4: APR-5000-DZ Large Bottom Pre-heater Airflow Setting (fixture not required)

Step A: set airflow 100%

1. Power on APR-5000-DZ and open software.
2. In admin mode (refer to appendix) enter System Setup menu.
3. Click on **Airflow** tab.
4. For **'Bottom Heat (Pre-heat)-Large'** airflow set slider to 100%.
5. Click 'apply' and 'ok' to save airflow setting
6. Proceed to large pre-heater max350C ramp rate check in step B.

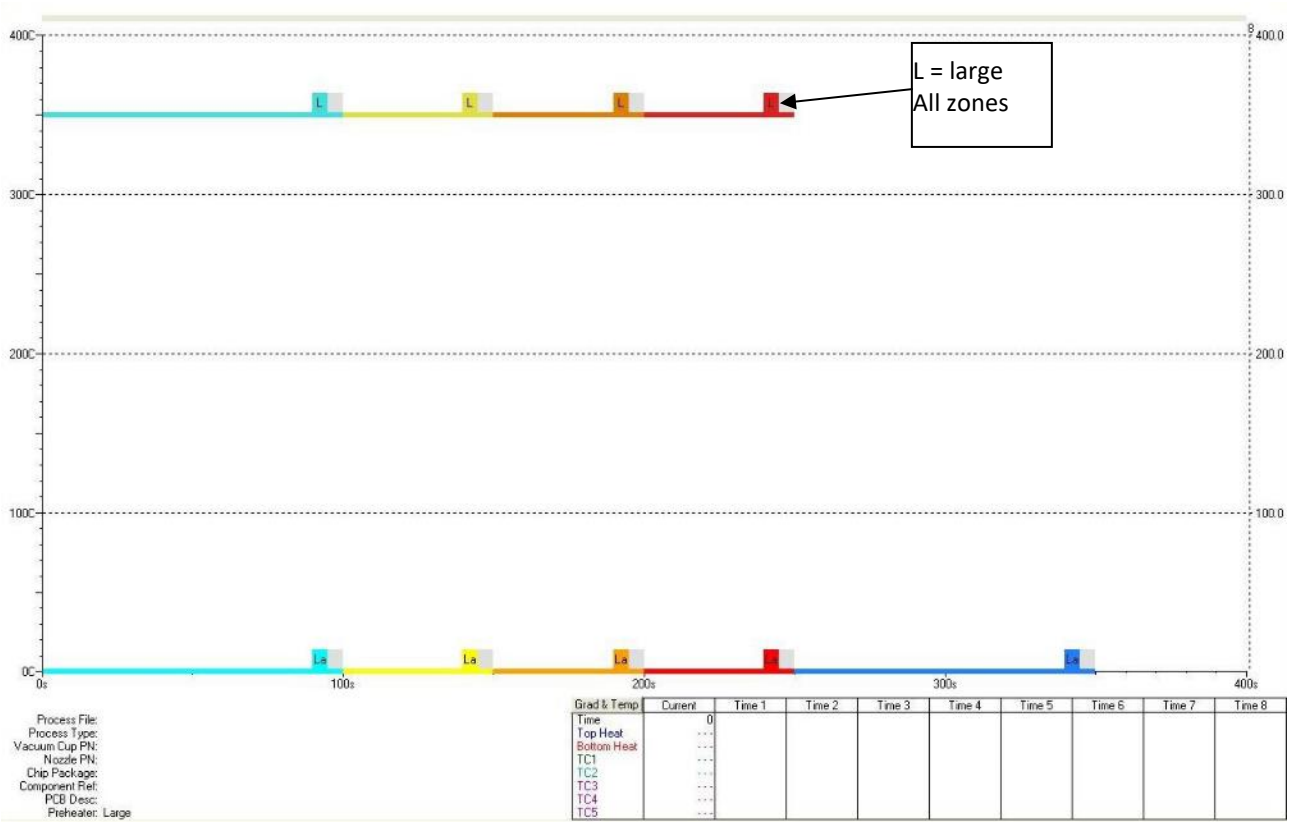
Step B: verify large pre-heater ramp rate to maximum 350C temperature

7. Go to software manual mode.
8. Set up max350C test profile for large bottom pre-heater.
9. Select L=large for bottom pre-heater for all heat zones.
10. Lower all top heater color bars to zero and La=low air
11. Raise all bottom heater heat zone color bars to 350C max (see chart for time settings)
12. Click and drag vertical time/temp lines to end of each heat zone to display all temps after run.
13. Click START button to run profile.
14. Verify that large bottom pre-heater reaches 350C maximum set point within 120 seconds.
15. If ramp rate verified ok, proceed to small bottom pre-heater airflow setting.
16. If ramp rate > 120s or large pre-heater does not reach 350C max, proceed to step C of this section.

Reference:

	TOP AIRFLOW	*TOP HEAT SET PT*	*BOTTOM HEAT SET PT (L)*	*TIME*
Zone 1	La	0C	350C	100s
Zone 2	La	0C	350C	50s
Zone 3	La	0C	350C	50s
Zone 4	La	0C	350C	50s
Zone 5	La	0C	0C	100s

Note: once bottom pre-heater has reached 350C in zone 1 or zone 2 it is ok to lower remaining heat zones to zero for the rest of the profile run.



Step C: Airflow adjustment to achieve max 350C temperature in 120 seconds (only if necessary)

1. This step only performed if large pre-heater does not pass step B verification.
2. As in step A, go to system setup and Airflow tab. Lower airflow to 95%.
3. Run max 350C verification in step B again.
4. If ramp rate verified ok, proceed to small bottom pre-heater airflow setting.
5. If ramp rate > 120s or large pre-heater does not reach 350C max, go to system setup > Airflow tab and lower large bottom airflow to 90%.
6. Run max 350C verification in step B again.

7. If ramp rate verified ok, proceed to small bottom pre-heater airflow setting.
8. If ramp rate > 120s or large pre-heater does not reach 350C max, go to system setup > Airflow tab and lower large bottom airflow to 88%.
9. Run max 350C verification in step B again.
10. If ramp rate verified ok, proceed to small bottom pre-heater airflow setting.
11. If ramp rate > 120s or large pre-heater does not reach 350C max, continue to lower large bottom heater airflow in -2% increments until max350C ramp rate is achieved in ≤ 120s.

NOTE: if having to lower airflow < 80% to achieve ramp rate please contact APR Customer Service

Section 5: APR-5000-DZ Small Bottom Pre-heater Airflow Setting (fixture not required)

Step A: set airflow 100%

17. Power on APR-5000-DZ and open software.
18. In admin mode (refer to appendix) enter System Setup menu.
19. Click on **Airflow** tab.
20. For **'Bottom Heat (Pre-heat)-Small'** airflow set slider to 100%.
21. Click 'apply' and 'ok' to save airflow setting
22. Proceed to small pre-heater max350C ramp rate check in step B.

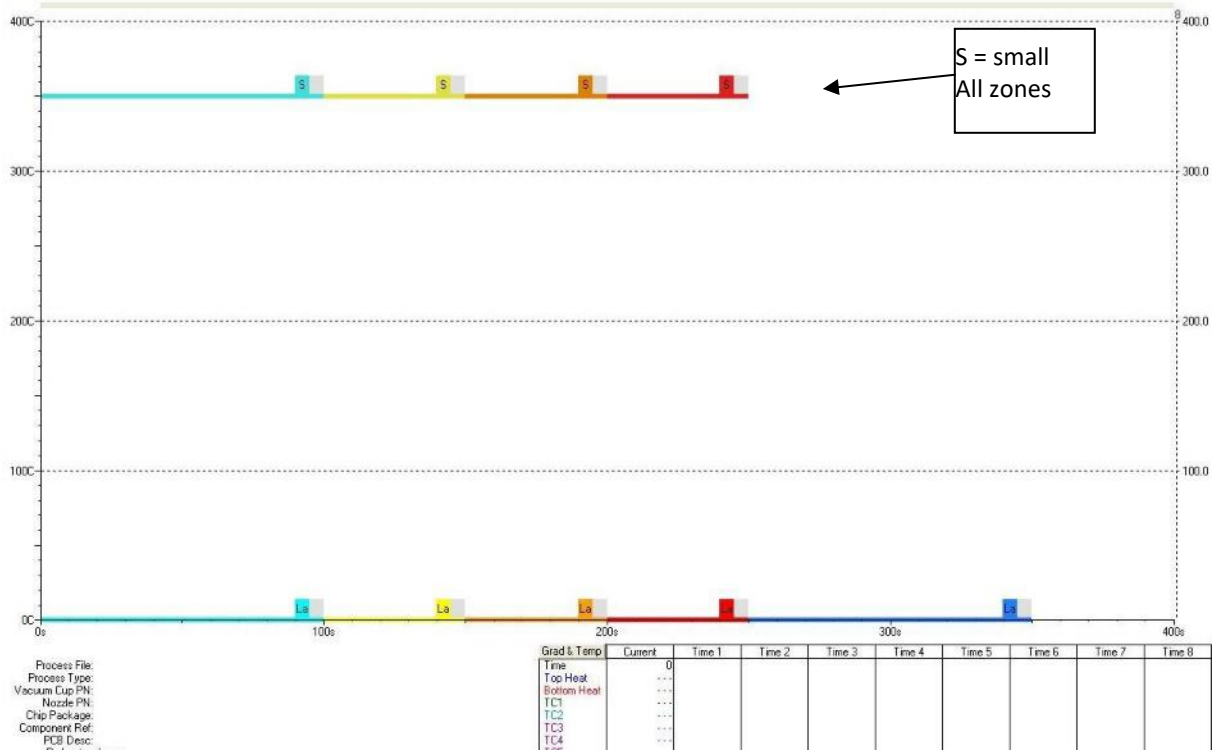
Step B: verify small pre-heater ramp rate to maximum 350C temperature

23. Go to software manual mode.
24. Set up max350C test profile for small bottom pre-heater.
25. Select S=small for bottom pre-heater for all heat zones.
26. Lower all top heater color bars to zero and La=low air
27. Raise all bottom heater heat zone color bars to 350C max (see chart for time settings)
28. Click and drag vertical time/temp lines to end of each heat zone to display all temps after run.
29. Click START button to run profile.
30. Verify that small bottom pre-heater reaches 350C maximum set point within 120 seconds.
31. If ramp rate verified ok, proceed to section 6 large pre-heater thermal calibration.
32. If ramp rate > 120s or small pre-heater does not reach 350C max, proceed to step C of this section.

    Reference:

	TOP AIRFLOW	*TOP HEAT SET PT*	*BOTTOM HEAT SET PT (S)*	*TIME*
Zone 1	La	0C	350C	100s
Zone 2	La	0C	350C	50s
Zone 3	La	0C	350C	50s
Zone 4	La	0C	350C	50s
Zone 5	La	0C	0C	100s

Note: once bottom pre-heater has reached 350C in zone 1 or zone 2 it is ok to lower remaining heat zones to zero for the rest of the profile run.



Step C: Airflow adjustment to achieve max 350C temperature in 120 seconds (only if necessary)

12. This step only performed if small pre-heater does not pass step B verification.
13. As in step A, go to system setup and Airflow tab. Lower small pre-heater airflow to 95%.
14. Run max 350C verification in step B again.
15. If ramp rate verified ok, proceed to small bottom pre-heater airflow setting.
16. If ramp rate > 120s or large pre-heater does not reach 350C max, go to system setup > Airflow tab and lower large bottom airflow to 90%.
17. Run max 350C verification in step B again.
18. If ramp rate verified ok, proceed to section 6 large pre-heater thermal calibration.
19. If ramp rate > 120s or large pre-heater does not reach 350C max, go to system setup > Airflow tab and lower large bottom airflow to 88%.
20. Run max 350C verification in step B again.
21. If ramp rate verified ok, proceed to section 6 large pre-heater thermal calibration.
22. If ramp rate > 120s or large pre-heater does not reach 350C max, continue to lower large bottom heater airflow in -2% increments until max350C ramp rate is achieved in ≤ 120s.

NOTE: if having to lower airflow < 80% to achieve ramp rate please contact APR Customer Service

Section 6: APR-5000 Large Bottom Pre-heater Thermal Calibration

***Required Equipment*:**
APR-5000 thermal/airflow calibration box fixture
APR-5000 thermal probe
NZA-490-490 reflow nozzle

NOTE: It is important to have consistent ambient conditions when running thermal calibrations. Conditions such as an air conditioner blowing downward directly onto the machine can cause inconsistent results; the machine should be located out of the influence of these areas.

The standard large pre-heater thermal calibration process consists of running the auto-calibration (option for up to 3 cycles) in system setup first; then running a verification profile in the manual mode. If additional offset adjustments are needed, these will be done in system setup and will be followed by a verification run in the manual mode.

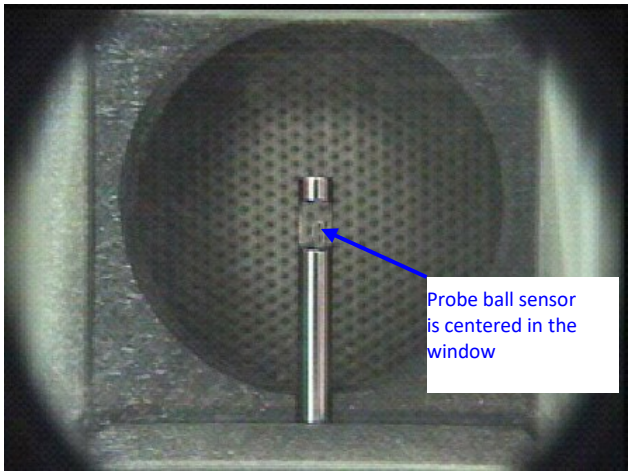
NOTE: If it is only needed to check existing thermal calibration then skip auto-calibration, set up fixtures and probe and run verification in manual mode step 4. Auto-calibration run will change settings automatically and should only be used to calibrate, not verify.

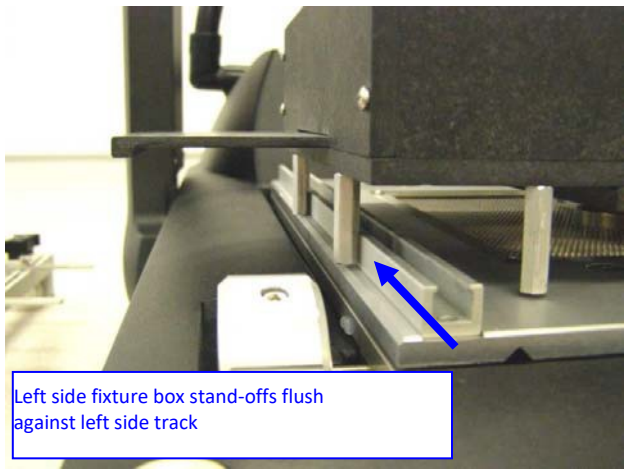
STEP 1 (LGPH): SYSTEM WARM-UP

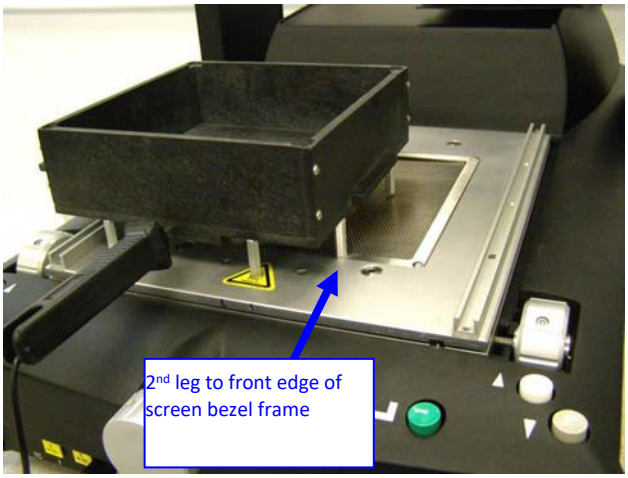
1. Power on APR-5000-DZ and open the software.
2. Run the manual mode default thermal profile (select all zones L = large pre-heater) to warm up the machine (Refer to Section 2).
3. After the machine has finished the cycle, click <next> to exit the manual mode and return to main screen.
4. Allow the machine to cool for approximately 10 minutes.

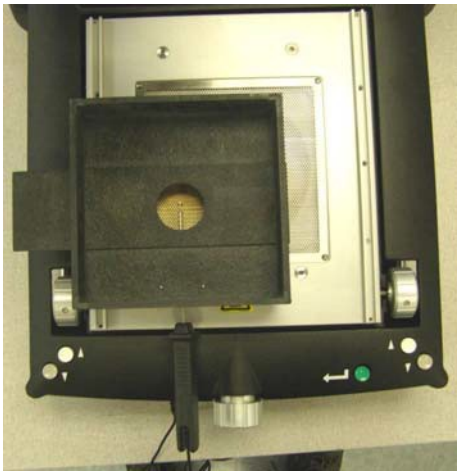
STEP 2 (LGPH): SET-UP CALIBRATION FIXTURE

1. Remove board holder rails or APR-TAB to free bottom pre-heater area.
2. Attach NZA-490-490 nozzle onto the reflow head. Use the y-axis control button to move the head to the rear and out of the way of the pre-heater area.
3. Insert the 8 standoffs into the threaded holes of the thermal calibration box fixture from the APR-CALKIT.

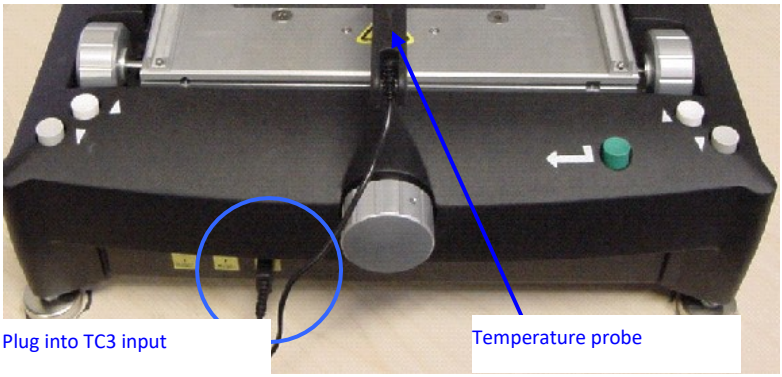






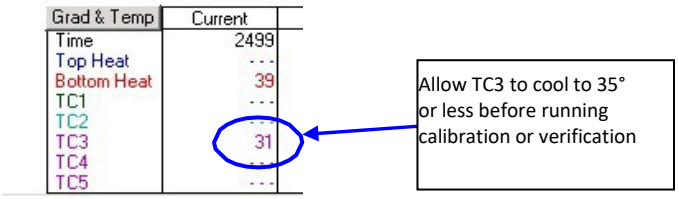


4. Insert the thermal probe from the APR-CALKIT into the box fixture. Center the ball sensor of the probe (as seen inside the probe opening) in the circular opening of the box fixture. Use the thumbscrew to hold the probe in place (Do not overtighten!).
5. For the pre-heater thermal verification, the box fixture will be open end UP and the thermal probe handle should be facing frontward.
6. Position the left side stand-offs of the calibration fixture along the outer edge of the left board holder track.
7. Next, position the second leg from front of calibration fixture along the front edge of the bottom pre-heater screen bezel frame.
8. The position of the calibration fixture places the fixture and thermal probe in the left corner of the bottom pre-heater.
9. The thermal probe handle should be facing frontward.
10. For the large pre-heater thermal calibration, the box fixture center window is OPEN.
11. Connect the thermal probe connector into TC3 on the front of the APR. TC3 is the only input that is used by the auto-calibration for feedback.

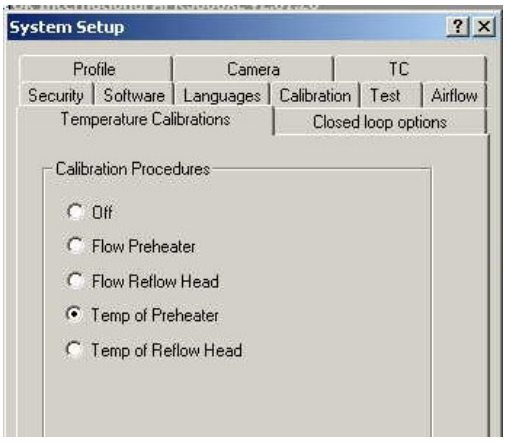


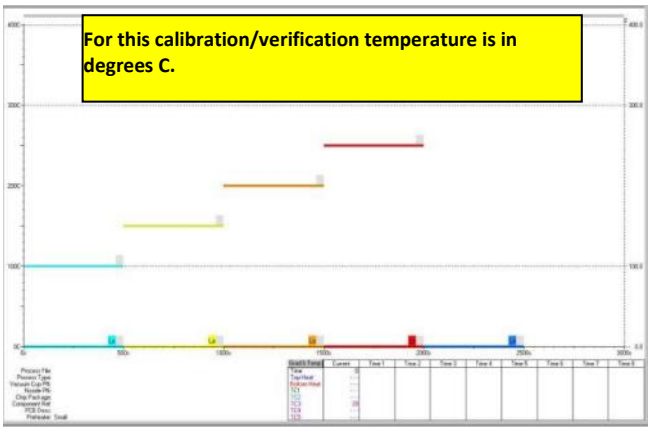
STEP 3 (LGPH): RUN AUTO-CALIBRATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external cooling fan or compressed air blowing on the TC probe/box fixture can be used to help cool down the system.



1. In admin mode (refer to appendix) enter System Setup menu.
2. Click on Temperature Calibrations tab. Select Temp Pre-heater. Click OK.
3. Select large pre-heater and select <next> to continue to next window.
4. Verify correct large bottom pre-heater calibration fixture setup (step 2) and TC probe input TC3.





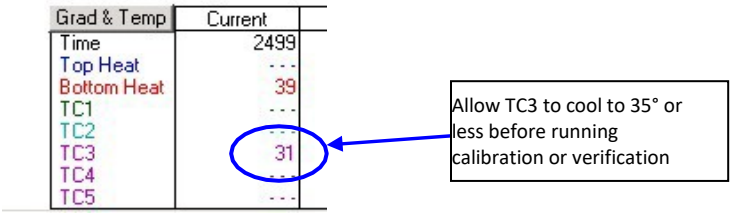
5. Continue to next window, "Select Start to run profile". The auto-cal profile is already setup.
6. Click <Start> and run the auto-calibration for one full cycle ((500s)x5=2500s=42 min)

IMPORTANT NOTE: while running the auto-calibration cycle, the profile plot on the screen will be changing continuously as the machine makes adjustments. It also may exhibit some unusual behavior. This auto-calibration plot is NOT used to verify final thermal calibration. The verification is done in manual mode afterward.

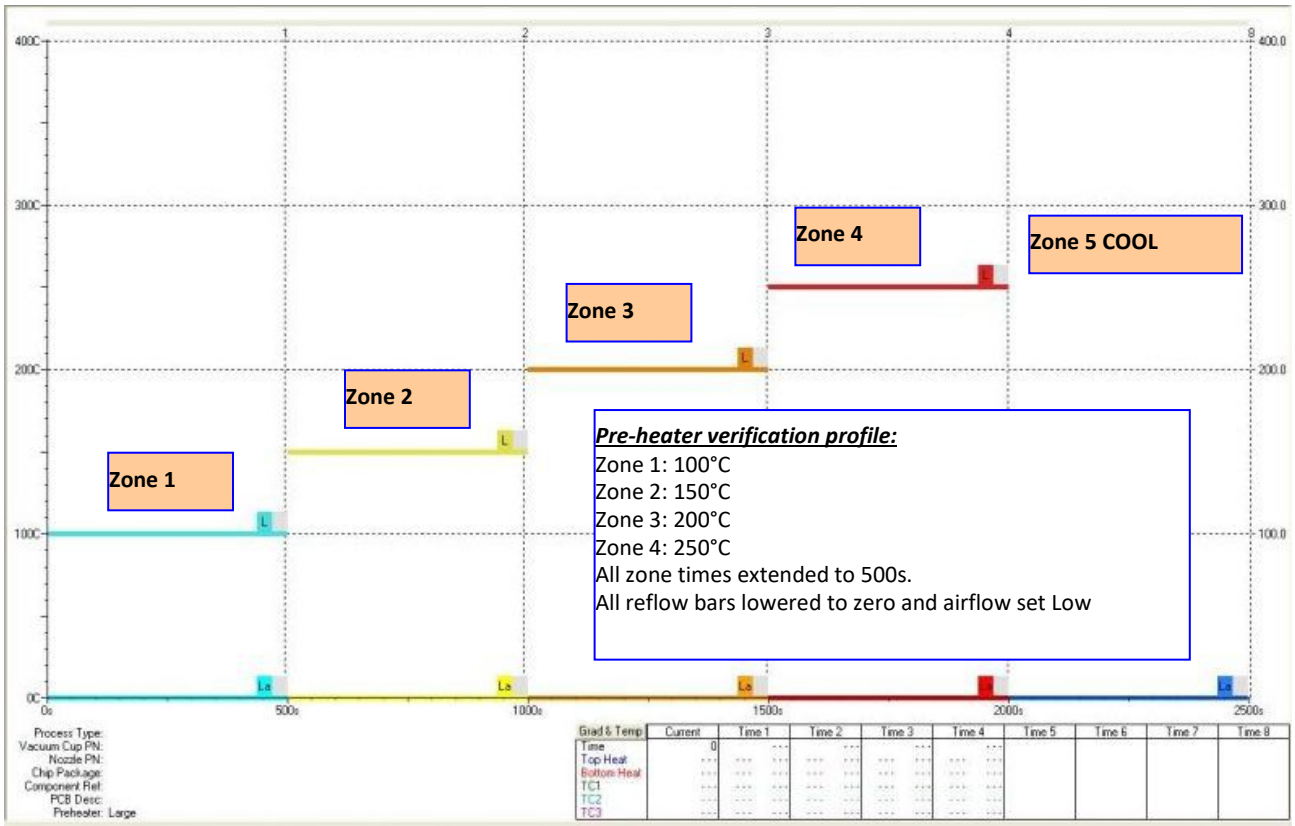
7. The software is set up to run 3 auto-calibration cycles in a row. After the 1st cycle, can continue following the software prompts and run the next 2 auto-calibration cycles (optional).
8. After completion of auto-calibration cycle(s), select <Finish> to save and exit the software calibration window.
9. The results of the auto-calibration run(s) must be verified in step 4.

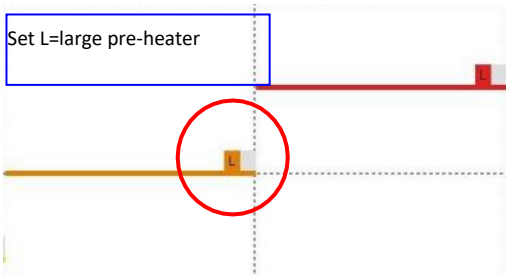
STEP 4 (LGPH): THERMAL VERIFICATION

NOTE: before running any thermal auto-calibration or verification, the probe thermal probe should be cooled down and reading TC3 ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



1. To verify the pre-heater thermal calibration, keep the thermal fixture & probe in same positions as step 2.
2. Click <Process Setup> and select the manual mode.
3. Continue to the manual mode command window.
4. Lower all reflow (top) heater temperature bars to zero and set top airflow to La= low.
5. Set all bottom heater zones to L = large pre-heater.
6. Keep the default pre-heater thermal profile temperature settings:
   Zones 1-4 temperature bars are set at 100º; 150º; 200º; 250º C.
   Extend time intervals for all 5 zones to 500s ea.

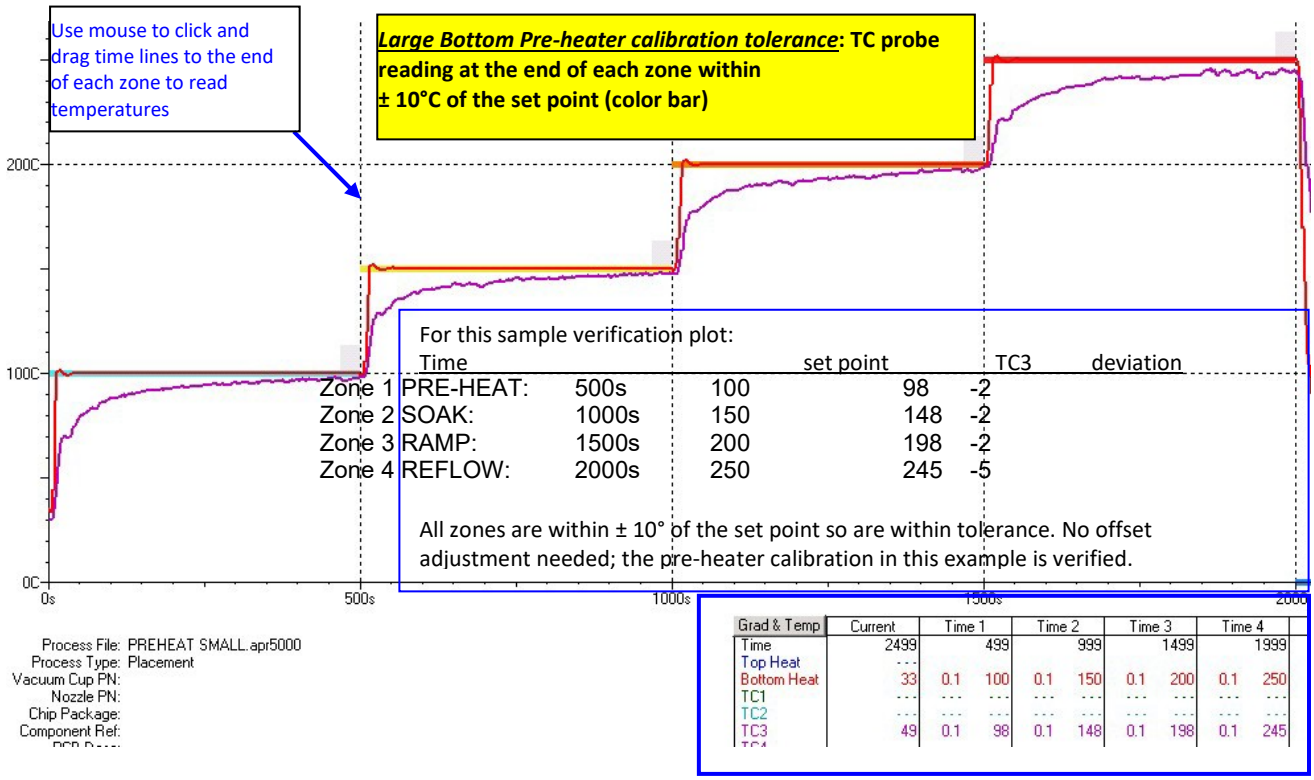




7. Click <start> to run the verification profile and finish the complete cycle.
8. After the cycle finishes, review TC 3 plot temperatures (from the probe) at the end of all 4 heat zones.
9. Position the vertical time lines at the end of each zone so that the exact TC 3 temperature can be reviewed at the bottom of the software screen: Time 1, Time 2, Time 3, Time 4.

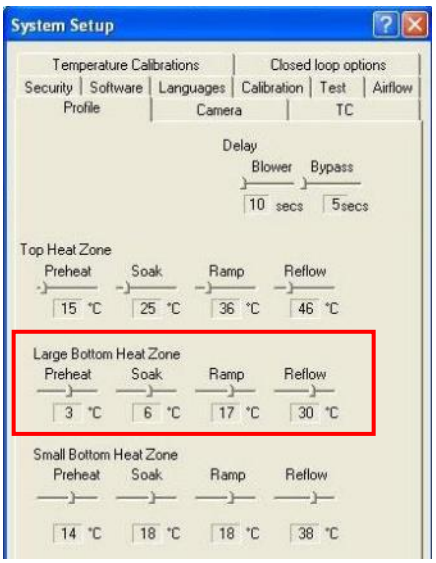
(can also drag and set horizontal temperature measurement dotted lines for reference)

10. For all 4 heat zones, record the TC3 temperature deviation from the bottom heater color bar set points. Example: zone 1 color bar set point = 100º C. TC 3 reading at end of zone 1 = 85º C. Record the 1st zone deviation as 100 - 85 = **- 15º C.**
11. <u>Acceptable tolerance is TC 3 probe reading **± 10º C** of the set point for each zone to verify the large bottom pre-heater calibration</u>.
12. If any of the zones are outside of this tolerance, can choose step 5 adjust manual offsets or can run 1 or 2 more auto-cal cycles then verify again.



STEP 5 (LGPH): MANUAL OFFSET ADJUSTMENT

1. The thermal offsets for each zone are positive or negative “shifts” to heater thermal output in order to achieve calibration. These are adjusted automatically during the auto-calibration cycle and they can also be manually adjusted if any of the 4 zones in the verification run still do not fall within ± 10° of the pre- heater set points.
2. Manual offset adjustments are based on the TC3 deviations from the set points, recorded in the verification plot (Step 4), and will be used to try to bring in the probe temperature readings at the end of each zone to within the ± 10°C tolerance.
3. After each manual offset adjustment, must run another manual mode verification profile to verify effect.
4. Exit the manual mode. In admin mode (refer to appendix) enter System Setup menu.
5. Select the <Profile> tab. The thermal offsets for each for the 4 zones for the large pre-heater are the 4 settings under **Large Bottom Heat Zone**.



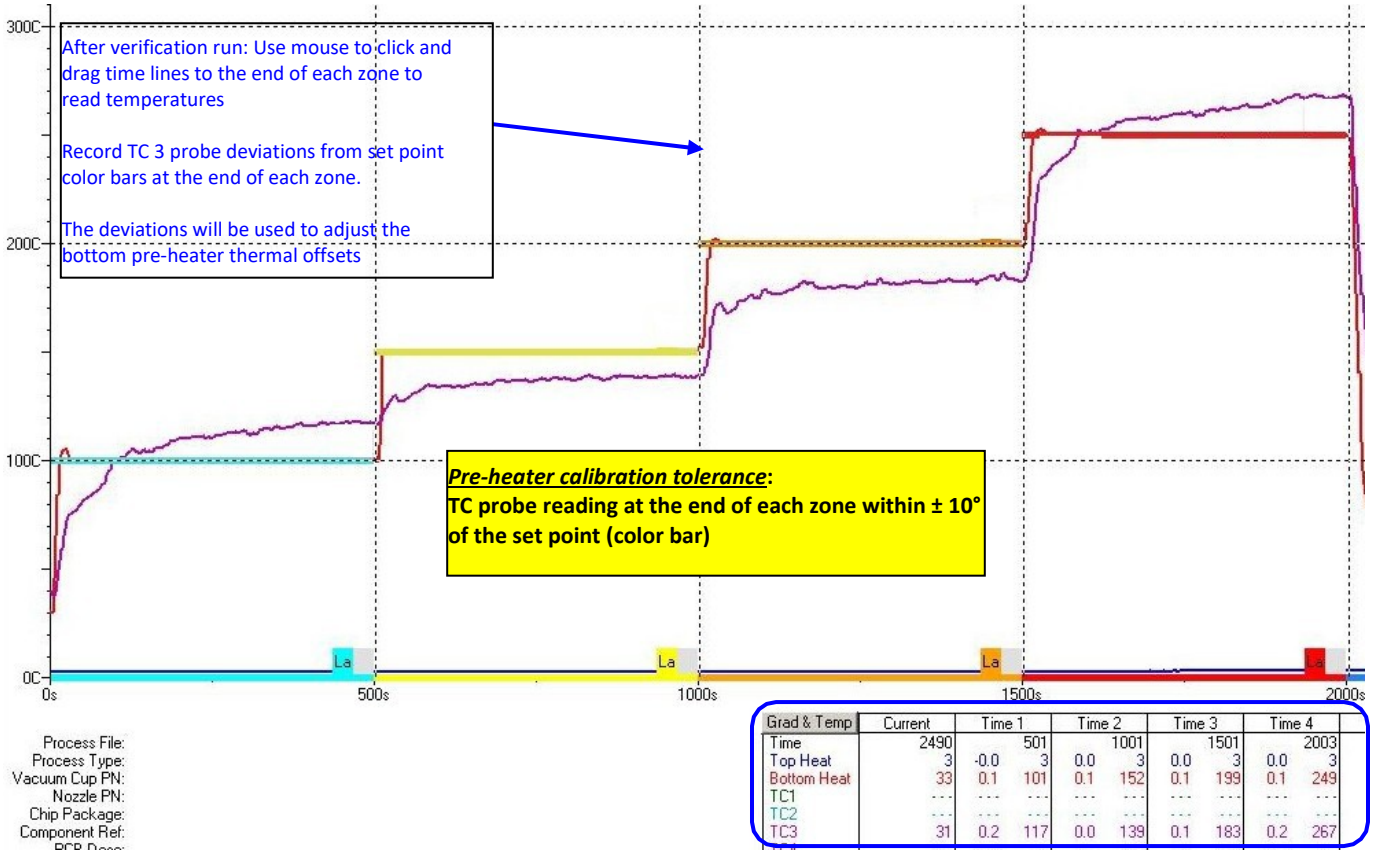
6. The thermal offsets are <u>not</u> necessarily one-to-one (1 degree offset to 1 degree actual) nor are they necessarily linear. However, the first offset adjustments will be made one-to-one and a 2nd verification run to see to the effect.

<u>Example</u>: Zone 1 set point color bar is 100°. The TC 3 probe reading for the 1st verification run at the end of zone 1 was 117°. The deviation is 117 - 100 = + 17°C. The reading is high, and over the tolerance (110° maximum). In the profile window, if zone 1 offset is originally set at 45, the 1st adjustment should 45 – 17 = 28, or the one-to-one amount of the deviation. We will try to lower zone 1 output by - 17°C.

If the offset does not happen to be one-to-one, this will be seen in the 2nd verification run. For example, if we expected zone 1 to now be at 100° but it turned out to be 83°, or double the effect of what was expected. In that case we would assume offset is roughly 1 to 2 and may adjust accordingly for 3rd run (use caution when estimating as results may not be linear).

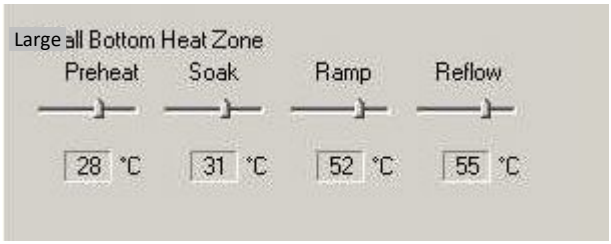
For the following example, TC3 at the end of all zones is outside of the ± 10° of the set points so the offsets for all zones will need adjustment and the verification profile run again:

Example: LGPH Verification run	**Time**	**Set point (°C)**	**TC3 Reading**	**Deviation from set pt**	**±10° Set pt Tolerance**	**Manual offset adjust 1-to-1**	**Original offset**	**New offset**
Zone 1 (Pre-heat)	500s	100	117	+17	High +7	-17	45	28
Zone 2 (Soak)	1000s	150	139	-11	Low -1	+11	20	31
Zone 3 (Ramp)	1500s	200	183	-17	Low -7	+17	35	52
Zone 4 (Reflow)	2000s	250	267	+17	Hight+7	-17	72	55



1st ADJUSTMENT to Large pre-heater offsets Deviations from 1st verification plot:
Zone 1 = + 17 deviation, adjust offset -17
Zone 2 = - 11 deviation, adjust offset +11
Zone 3 = - 17 deviation, adjust offset +17
Zone 4 = + 17 deviation, adjust offset -17

Large pre-heater offsets AFTER 1st adjustment:
Zone 1: 45 – 17 = 28
Zone 2: 20 + 11 = 31
Zone 3: 35 + 17 = 52
Zone 4: 72 – 17 = 55

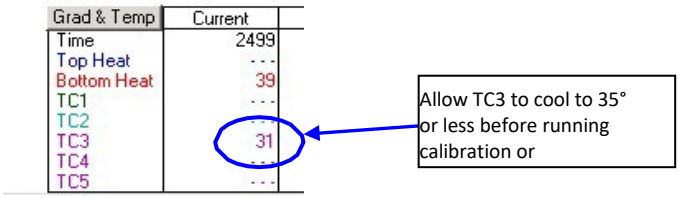


7. Using the recorded TC3 deviations from the verification plot, adjust the offsets for <Profile> Large Bottom Heat Zone in each of the 4 zones if out of the ± 10° C tolerance.
8. After making the offset adjustments, click <APPLY>, then <OK>.

The changes to the offsets will not be saved unless this is done.

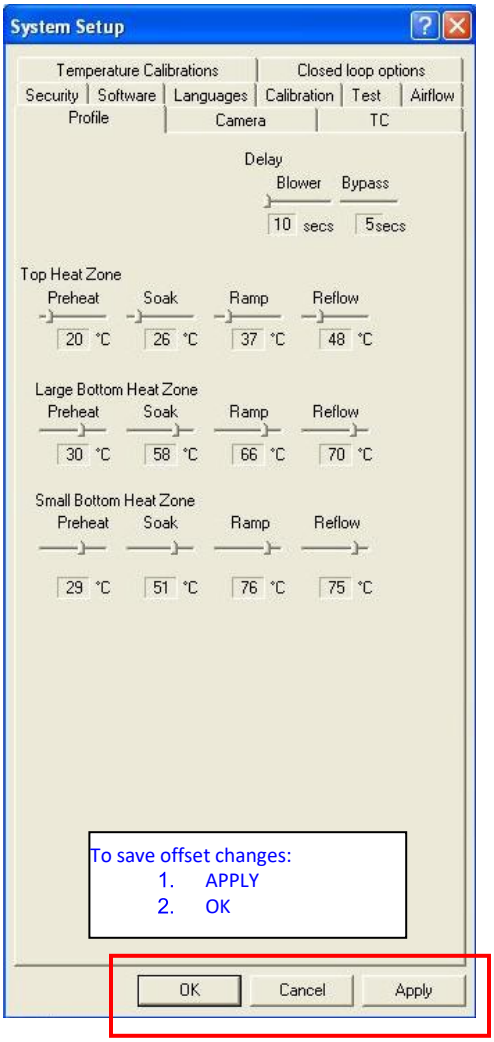
9. In the manual mode, run the 2nd large bottom pre-heater verification.

Make sure the TC3 probe reading is cooled down to ≤ 35º C before starting the cycle again.



10. For 2nd run, review all deviations between set point and TC 3 readings at the end of each zone. If all 4 zones are within the ± 10º C tolerance of TC 3 probe to set point color bar then large bottom pre-heater has been verified and calibrated.

If further offset adjustments are necessary, repeat above procedure for Step 5 until large bottom pre- heater is calibrated and verified.



Section 7: APR-5000-DZ Small Bottom Pre-heater Thermal Calibration

Required Equipment:

APR-5000 thermal/airflow calibration box fixture
APR-5000 thermal probe
NZA-490-490 reflow nozzle

NOTE: It is important to have consistent ambient conditions when running thermal calibrations. Conditions such as an air conditioner blowing downward directly onto the machine can cause inconsistent results; the machine should be located out of the influence of these areas.

The standard small pre-heater thermal calibration process consists of running the auto-calibration (option for up to 3 cycles) in system setup first; then running a verification profile in the manual mode. If additional offset adjustments are needed, these will be done in system setup and will be followed by a verification run in the manual mode.

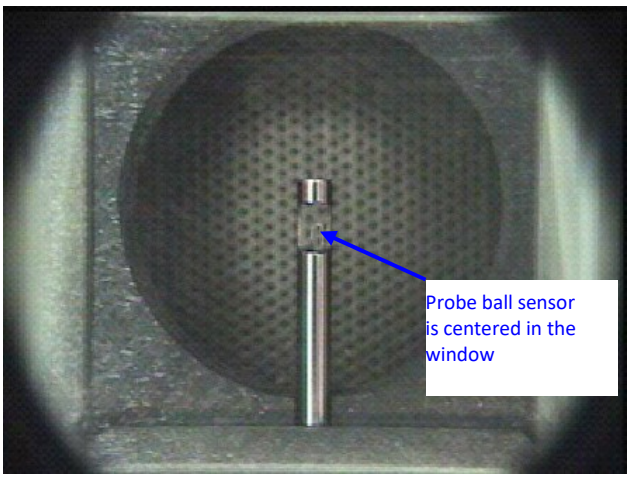
NOTE: If it is only needed to check existing thermal calibration then skip auto-calibration, set up fixtures and probe and run verification in manual mode step 4. Auto-calibration run will change settings automatically and should only be used to calibrate, not verify.

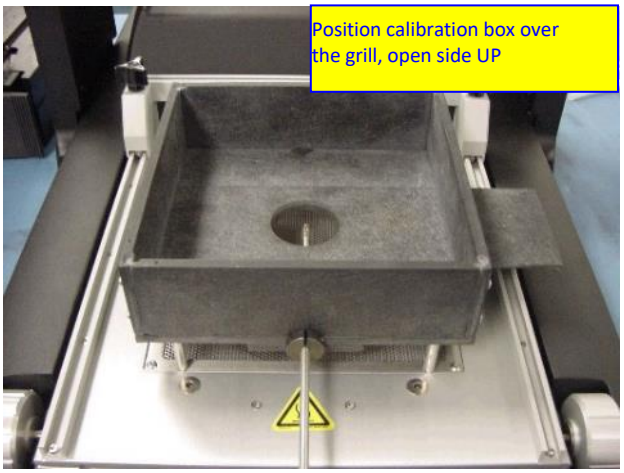
STEP 1 (SMPH): SYSTEM WARM-UP

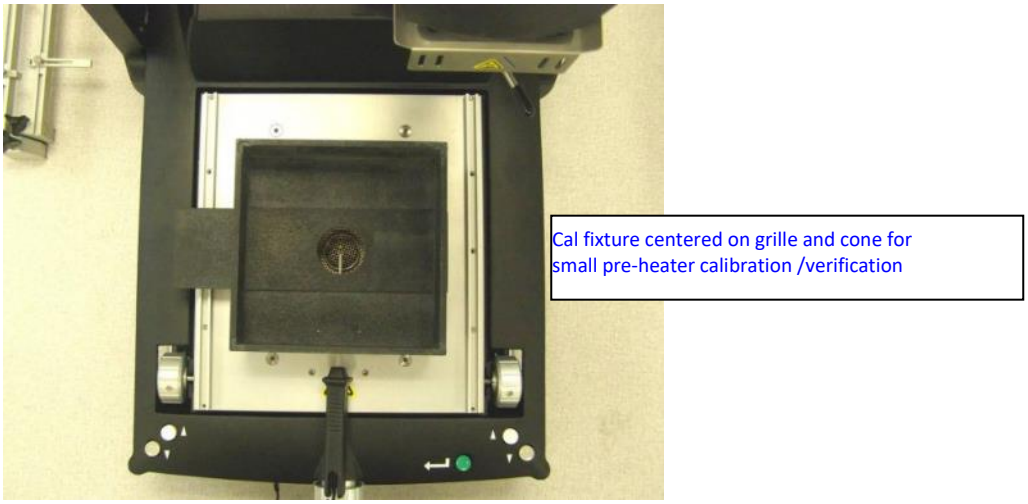
1. Power on APR-5000-DZ and open the software.
2. Run the manual mode default thermal profile (select all zones S = small pre-heater) to warm up the machine (Refer to Section 2).
3. After the machine has finished the cycle, click <next> to exit the manual mode and return to main screen.
4. Allow the machine to cool for approximately 10 minutes.

STEP 2 (SMPH): SET-UP CALIBRATION FIXTURE

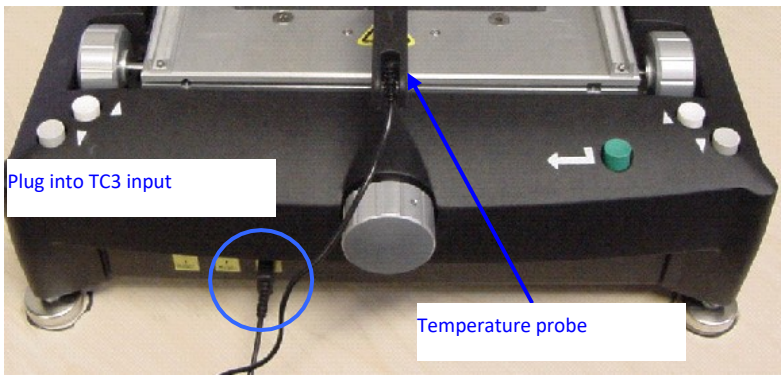
1. Remove board holder rails or APR-TAB to free bottom pre-heater area.
2. Attach NZA-490-490 nozzle onto the reflow head. Use the y-axis control to move the head to the rear and out of the way of the pre-heater area.
3. Insert the 8 standoffs into the thermal calibration box fixture from the APR-CALKIT.





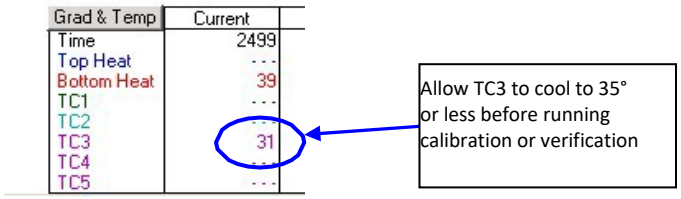


4. Insert the thermal probe from the APR-CALKIT into the box fixture. Center the ball sensor of the probe (as seen inside the probe opening) in the circular opening of the box fixture. Use the thumbscrew to hold the probe in place (Do not overtighten!).
5. For the small pre-heater thermal verification, the box fixture will be open end UP. Position the fixture so that the circular opening and probe are in the center of the grille. The open center hole in fixture should be approximately centered on the small pre-heater cone. The standoffs should fit within the grille outer perimeter. The thermal probe handle should be facing frontward.
6. For the small pre-heater thermal calibration, the box fixture center window is OPEN.
7. Connect the thermal probe connector into TC3 on the front of the APR. TC3 is the only input that is used by the auto-calibration for feedback.

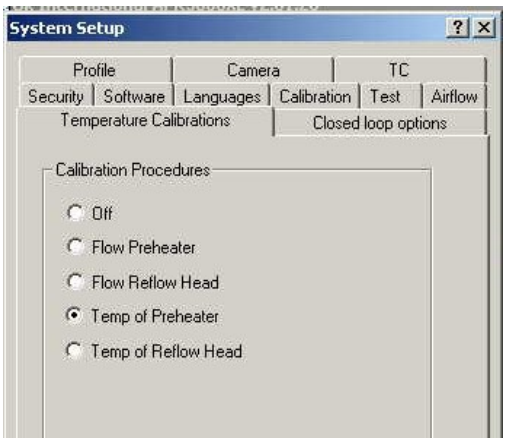


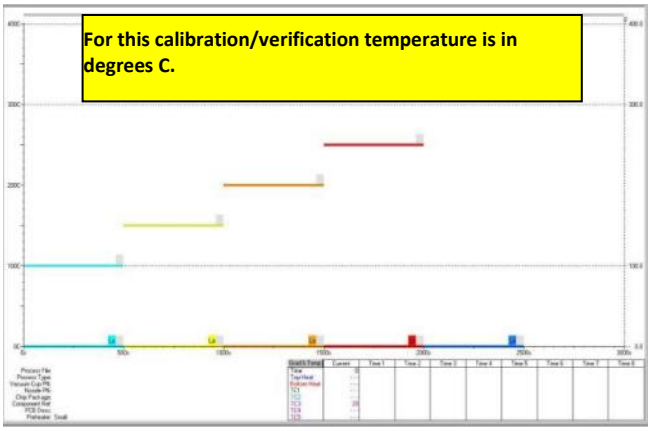
STEP 3 (SMPH): RUN AUTO-CALIBRATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



1. In admin mode (refer to appendix) enter System Setup menu.
2. Click on Temperature Calibrations tab. Select Temp Pre-heater. Click OK.
3. Select small pre-heater and select <next> to continue to next window.
4. Verify correct small bottom pre-heater calibration fixture setup (step 2) and TC probe input TC3.





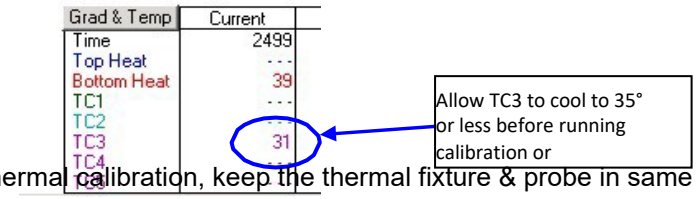
8. Continue to next window, "Select Start to run profile". The auto-cal profile is already setup.
9. Click <Start> and run the auto-calibration for one full cycle ((500s)x5=2500s=42 min)

IMPORTANT NOTE: while running the auto-calibration cycle, the profile plot on the screen will be changing continuously as the machine makes adjustments. It also may exhibit some unusual behavior. This auto-calibration plot is NOT used to verify final thermal calibration. The verification is done in manual mode afterward.

10. The software is set up to run 3 auto-calibration cycles in a row. After the 1st cycle, can continue following the software prompts and run the next 2 auto-calibration cycles (optional).
11. After completion of auto-calibration cycle(s), select <Finish> to save and exit the software calibration window.
12. The results of the auto-calibration run(s) must be verified in step 4.

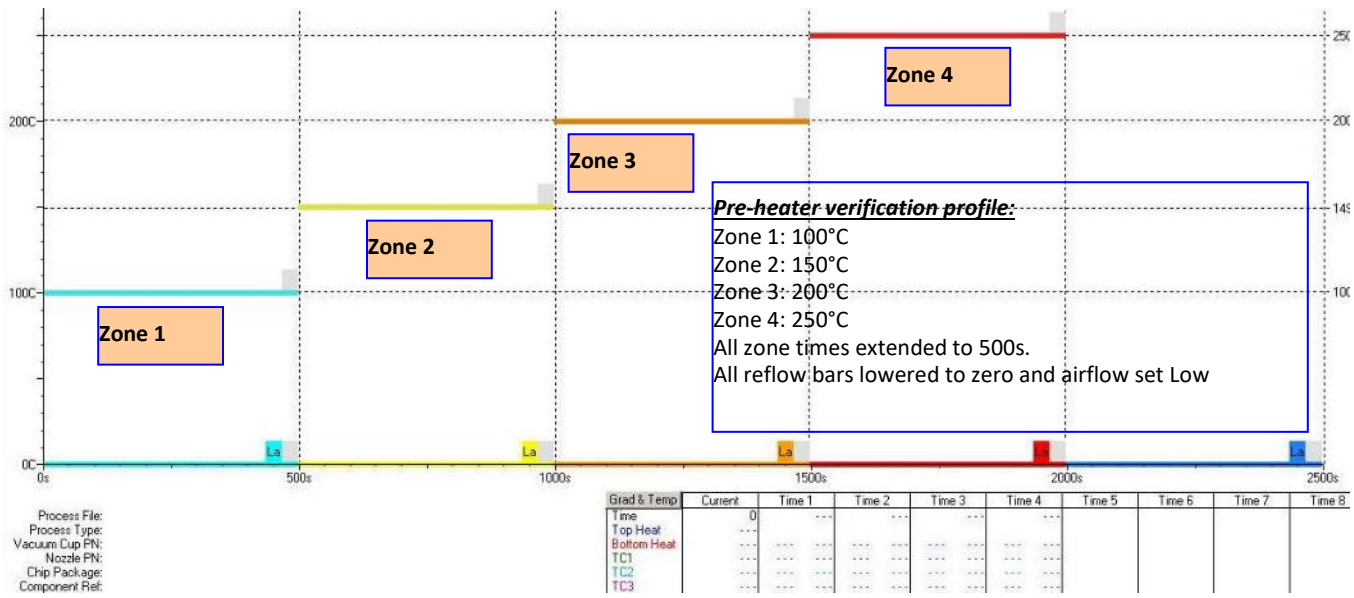
STEP 4 (SMPH): THERMAL VERIFICATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



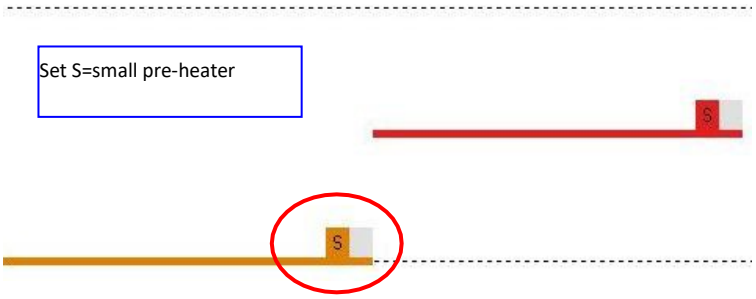
1. To verify the pre-heater thermal calibration, keep the thermal fixture & probe in same positions as step 2.
2. Click <Process Setup> and select the manual mode.
3. Continue to the manual mode command window.
4. Lower all reflow (top) heater temperature bars to zero and set top airflow to La= low.
5. Set all bottom heater zones to S = small pre-heater.
6. Keep the default pre-heater thermal profile temperature settings:

Zones 1-4 temperature bars are set at 100º; 150º; 200º; 250º C. Extend time intervals for all 5 zones to 500s ea.



7. Click <start> to run the verification profile and finish the complete cycle.
8. After the cycle finishes, review TC 3 plot temperatures (from the probe) at the end of all 4 heat zones.
9. Position the vertical time lines at the end of each zone so that the exact TC 3 temperature can be reviewed at the bottom of the software screen: Time 1, Time 2, Time 3, Time 4.

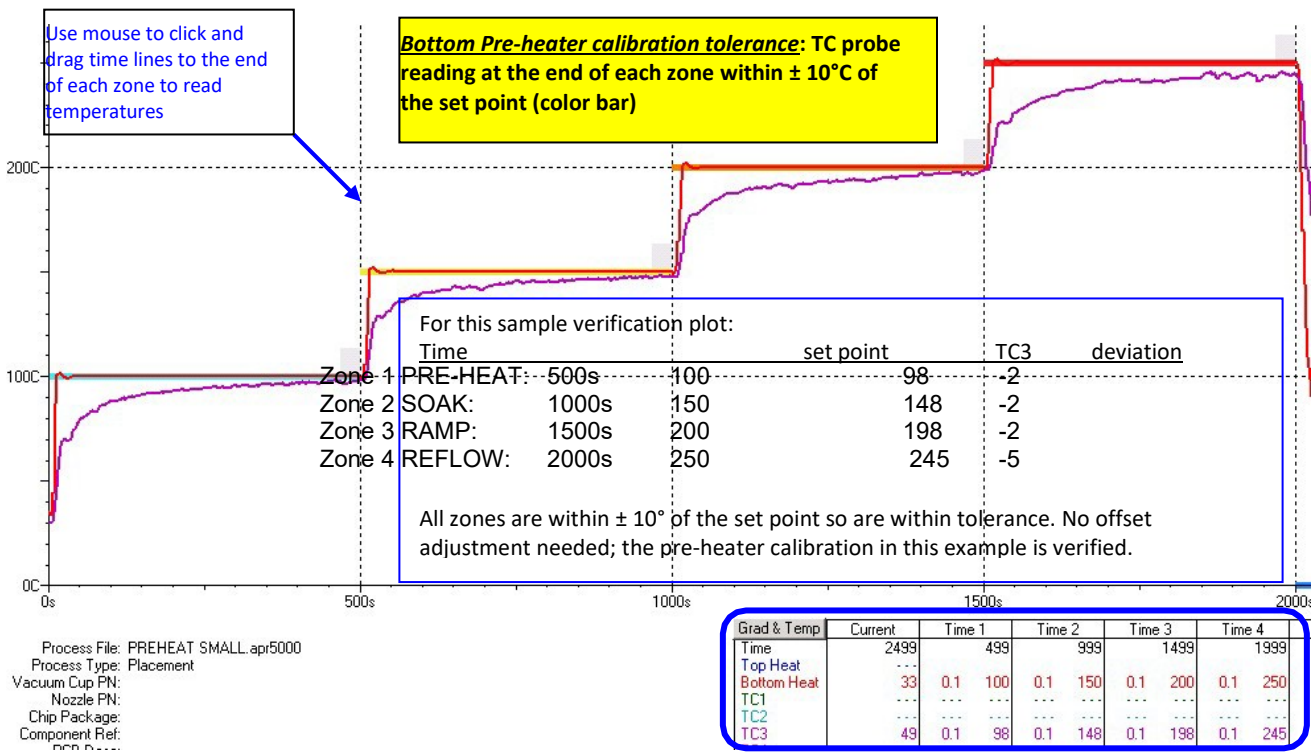
(can also drag and set horizontal temperature measurement dotted lines for reference)



10. For all 4 heat zones, record the TC3 temperature deviation from the bottom heater color bar set points. Example: zone 1 color bar set point = 100º C. TC 3 reading at end of zone 1 = 85º C. Record the 1st zone deviation as 100 - 85 = **- 15º C.**

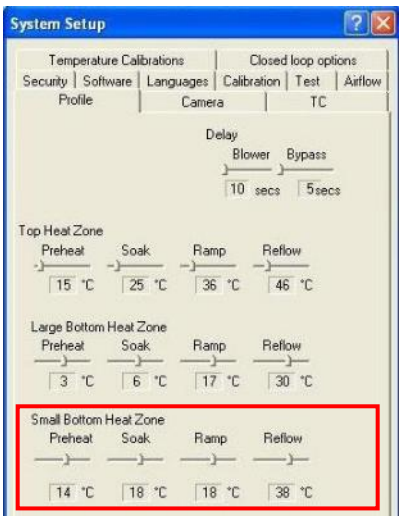
11. <u>Acceptable tolerance is TC 3 probe reading **± 10º C** of the set point to verify the small bottom pre-heater calibration</u>.

12. If any of the zones are outside of this tolerance, can choose step 5 manual offsets or can run 1 or 2 more auto-cal cycles then verify again.



STEP 5 (SMPH): OFFSET ADJUSTMENT

1. The thermal offsets for each zone are positive or negative “shifts” to heater thermal output in order to achieve calibration. These are adjusted automatically during the auto-calibration cycle and they can also be manually adjusted if any of the 4 zones in the verification run still do not fall within ± 10° of the pre- heater set points.
2. Manual offset adjustments are based on the TC3 deviations from the set points, recorded in the verification plot (Step 4), and will be used to try to bring in the probe temperature readings at the end of each zone to within the ± 10°C tolerance.
3. After each manual offset adjustment, must run another manual mode verification profile to verify effect.
4. Exit the manual mode. In admin mode (refer to appendix) enter System Setup menu.
5. Select the <Profile> tab. The thermal offsets for each for the 4 zones for the large pre-heater are the 4 settings under **Small Bottom Heat Zone**.



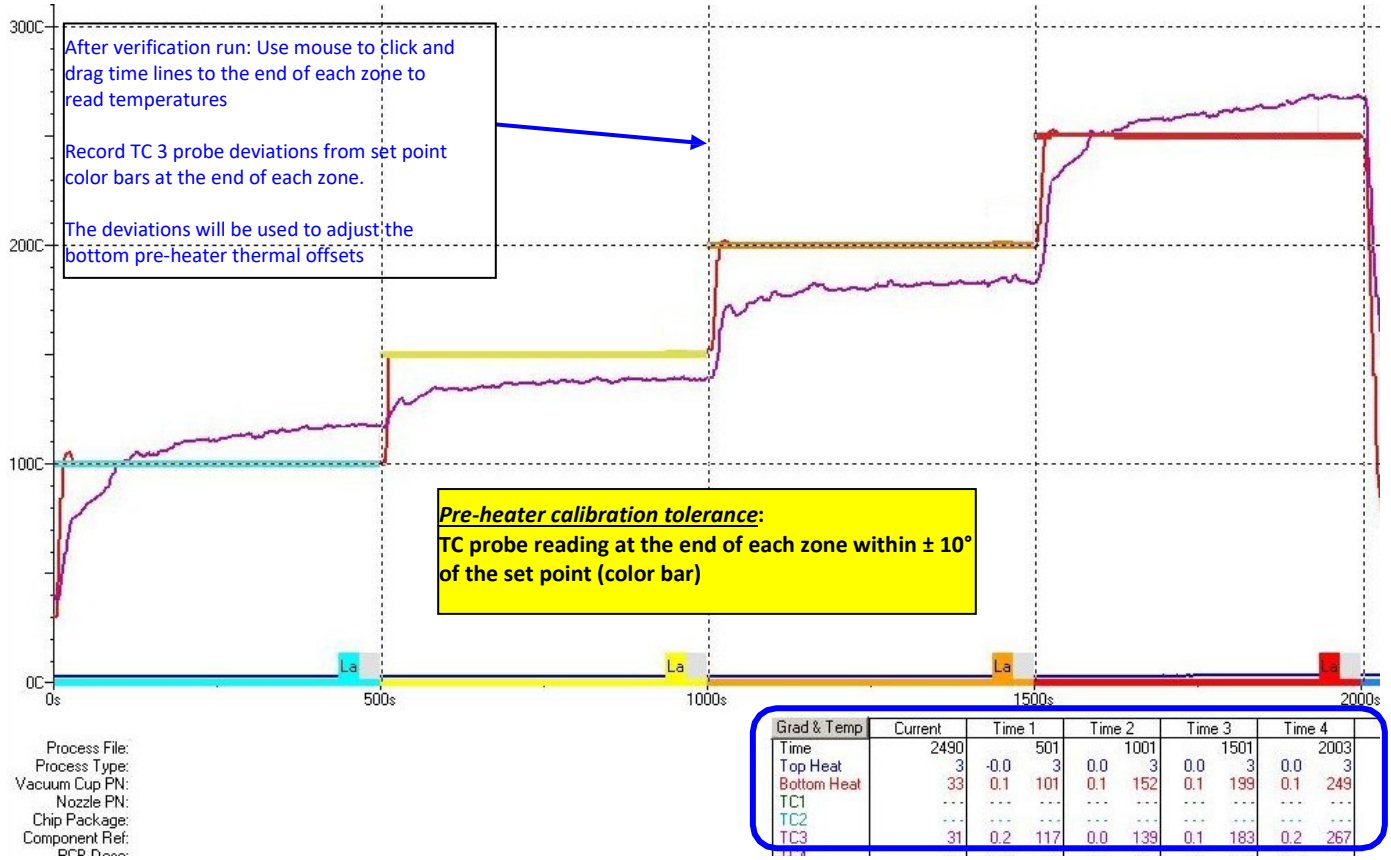
6. The thermal offsets are <u>not</u> necessarily one-to-one (1 degree offset to 1 degree actual) nor are they necessarily linear. However, the first offset adjustments will be made one-to-one and a 2nd verification run to see to the effect.

Example: Zone 1 set point color bar is 100°C. The TC 3 probe reading for the 1st verification run at the end of zone 1 was 117°C. The deviation is 117 - 100 = + 17°C. The reading is high, and over the tolerance (110° maximum). In the profile window, if zone 1 offset is originally set at 45, the 1st adjustment should be 45 – 17 = 28, or the one-to-one amount of the deviation. We will try to lower zone 1 output by
- 17° C.

If the offset does not happen to be one-to-one, this will be seen in the 2nd verification run. For example, if we expected zone 1 to now be at 100° but it turned out to be 83°, or double the effect of what was expected. In that case we would assume offset is roughly 1 to 2 and may adjust accordingly for 3rd run (use caution when estimating as results may not be linear).

For the following example, TC3 at the end of all zones is outside of the ± 10° of the set points so the offsets for all zones will need adjustment and the verification profile run again:

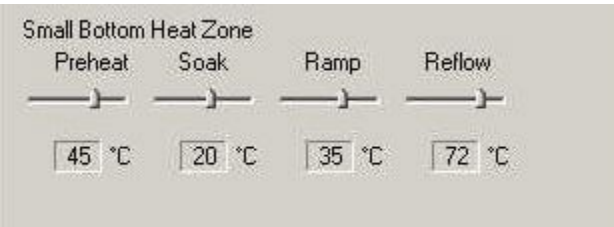
Example: SMPH Verification run	**Time**	**Set point (°C)**	**TC3 Reading**	**Deviation from set pt**	**±10° Set pt Tolerance**	**Manual offset adjust 1-to-1**	**Original offset**	**New offset**
Zone 1 (Pre-heat)	500s	100	117	+17	High +7	-17	45	28
Zone 2 (Soak)	1000s	150	139	-11	Low -1	+11	20	31
Zone 3 (Ramp)	1500s	200	183	-17	Low -7	+17	35	52
Zone 4 (Reflow)	2000s	250	267	+17	Hight+7	-17	72	55

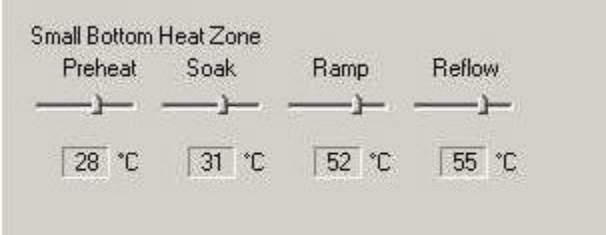


Grad & Temp	Current	Time 1		Time 2		Time 3		Time 4	
Time	2490		501		1001		1501		2003
Top Heat	3	-0.0	3	0.0	3	0.0	3	0.0	3
Bottom Heat	33	0.1	101	0.1	152	0.1	199	0.1	249
TC1	---	---	---	---	---	---	---	---	---
TC2	---	---	---	---	---	---	---	---	---
TC3	31	0.2	117	0.0	139	0.1	183	0.2	267

1st ADJUSTMENT to Small pre-heater offsets Deviations from 1st verification plot:
Zone 1 = + 17 deviation, adjust offset -17
Zone 2 = - 11 deviation, adjust offset +11
Zone 3 = - 17 deviation, adjust offset +17
Zone 4 = + 17 deviation, adjust offset -17

Small pre-heater offsets AFTER 1st adjustment:
Zone 1: 45 – 17 = 28
Zone 2: 20 + 11 = 31
Zone 3: 35 + 17 = 52
Zone 4: 72 – 17 = 55



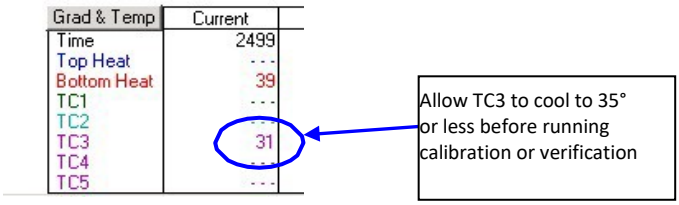


11. Using the recorded TC3 deviations from the verification plot, adjust the offsets for <Profile> Small Bottom Heat Zone in each of the 4 zones if out of the ± 10° C tolerance.
12. After making the offset adjustments, click <APPLY>, then <OK>.

The changes to the offsets will not be saved unless this is done

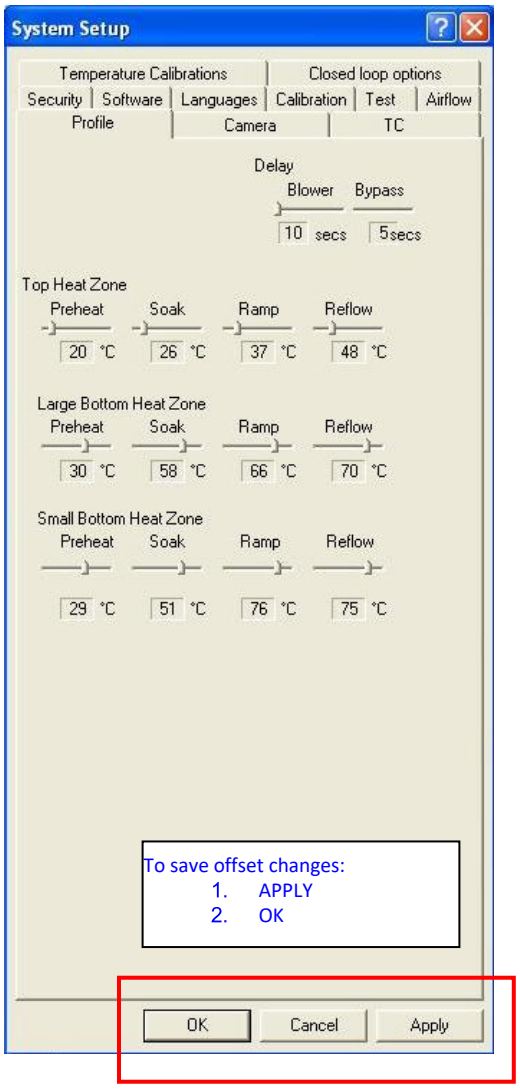
In the manual mode, run the 2nd small bottom pre- heater verification.

Make sure the TC3 probe reading is cooled down to ≤ 35º C before starting the cycle again.



13. For 2nd run, review all deviations between set point and TC 3 readings at the end of each zone. If all 4 zones are within the ± 10º C tolerance of TC 3 probe to set point color bar then small bottom pre-heater has been verified and calibrated.

If further offset adjustments are necessary, repeat above procedure for Step 5 until small bottom pre-heater is calibrated and verified.



Section 8: APR-5000-DZ Reflow Head (Top Heater) Thermal Calibration

Required Equipment:
APR-5000 thermal/airflow calibration box fixture
APR-5000 thermal probe
NZA-490-490 reflow nozzle

NOTE: It is important to have consistent ambient conditions when running thermal calibrations. Conditions such as an air conditioner blowing downward directly onto the machine can cause inconsistent results; the machine should be located out of the influence of these areas.

The standard top reflow thermal calibration process consists of running the auto-calibration (option for up to 3 cycles) in system setup first; then running a verification profile in the manual mode. If additional offset adjustments are needed, these will be done in system setup and will be followed by a verification run in the manual mode.

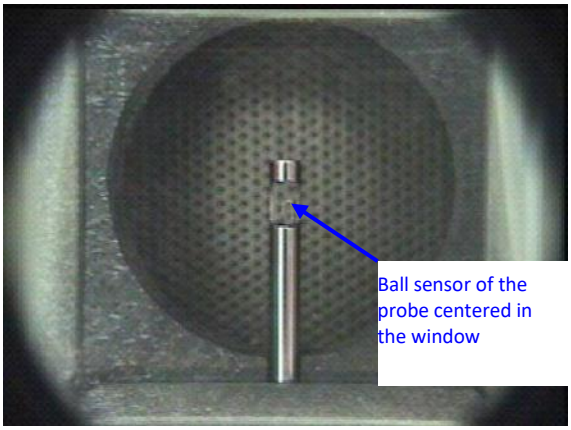
NOTE: If it is only needed to check existing thermal calibration then skip auto-calibration, set up fixtures and probe and run verification in manual mode. Auto-calibration will change settings when run.

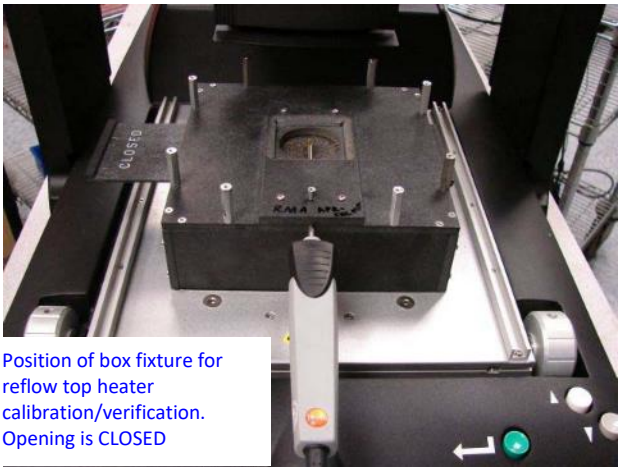
STEP 1 (TOP): SYSTEM WARM-UP

1. Power on APR-5000 and open the software.
2. Run the default thermal profile to warm up the machine (Refer to Section 2).
3. After the machine has finished the cycle, click <next> to exit the manual mode and return to main screen.
4. Allow the machine to cool for approximately 15-20 minutes.

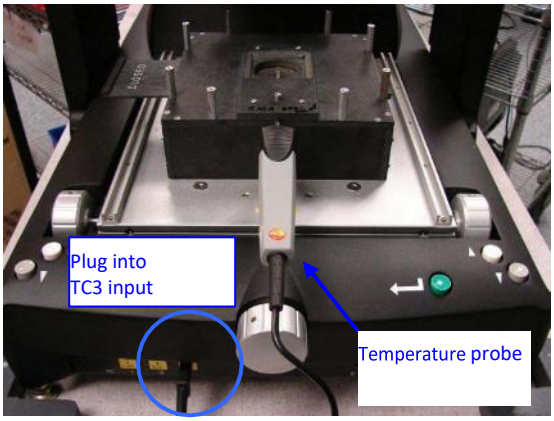
STEP 2 (TOP): SET UP CALIBRATION FIXTURE

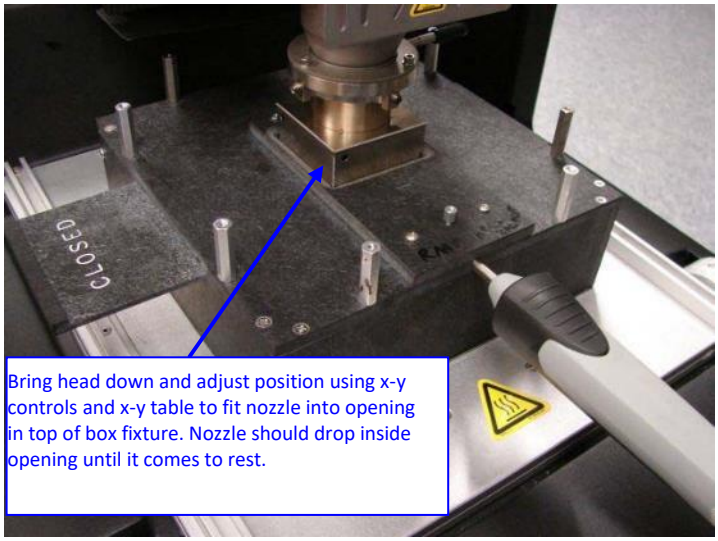
1. Remove board holder rails or APR-TAB to free bottom pre-heater area.
2. Attach NZA-490-490 nozzle onto the reflow head.
3. Insert the 8 standoffs into the thermal calibration box fixture from the APR-CALKIT.
4. Insert the thermal probe from the APR-CALKIT into the box fixture. Center the ball sensor of the probe (inside the probe opening) in the circular opening of the box fixture. Use the thumbscrew to hold the probe in place (Do not overtighten!).

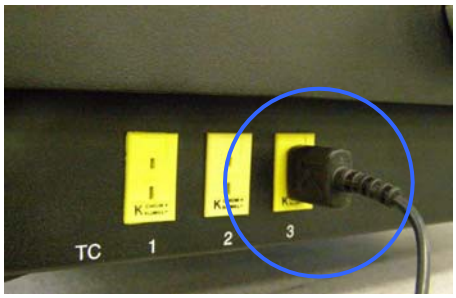




5. For the reflow top heater thermal calibration or verification the box fixture will be open end DOWN. Place the calibration box fixture onto the heater bowl grill. The pre-cut holes on the box fixture should fit over the grill screws and position the box. The center hole in fixture should be approximately centered on the small pre-heater cone. The thermal probe handle should be facing frontward.
6. For the top reflow heater thermal calibration, the box fixture center window is CLOSED.
7. Connect the thermal probe connector into TC3 on the front of the APR. TC3 is the only input that is used by the auto-calibration for feedback.



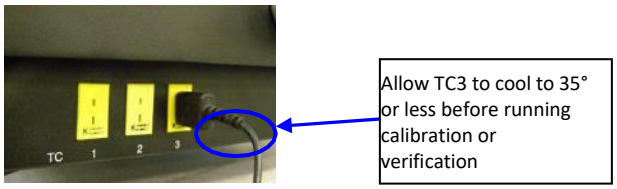




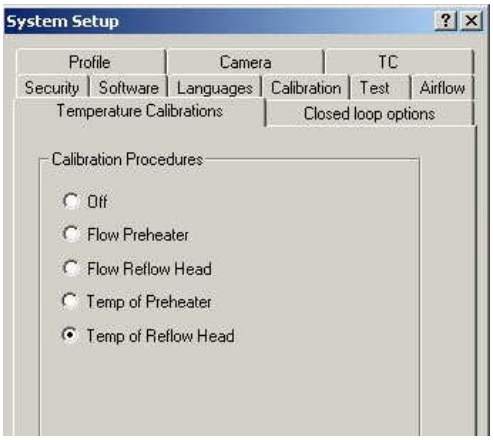
8. For auto-calibration, NZA-490-490 reflow head nozzle will be positioned into the top of box fixture as shown during the software setup procedure for calibration run (see next section) using z-axis control buttons to bring down the head and aligning nozzle into box opening by x and y gantry adjustment and x-y table. For thermal verification, reflow head nozzle will be positioned into the top of box fixture in the manual mode using same controls. In both cases the reflow nozzle should drop inside opening until it comes to rest.

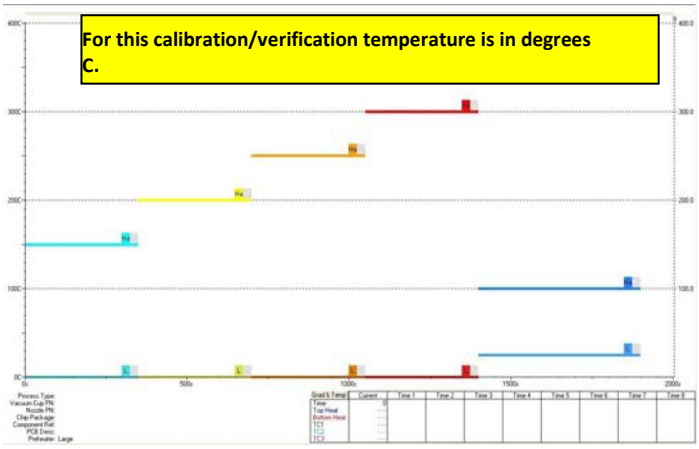
STEP 3 (TOP): AUTO-CALIBRATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.



1. In admin mode (refer to appendix) enter System Setup menu.
2. Click on Temperature Calibrations tab. Select Temp of Reflow Head. Click OK.
3. Verify correct small bottom pre-heater calibration fixture setup (step 2) and TC probe input TC3.
4. Use the x and y brake release buttons on head face plate to move the head position so that the NZA-490-490 nozzle is roughly aligned with the opening on top of the box fixture.
5. Bring the head down and align NZA-490-490 nozzle so that it drops down into the opening on top of the box fixture. Use the x-y table fine adjustment until the nozzle drops inside the opening and comes to rest.





6. Continue to next window, "Select Start to run profile". The auto-cal profile is already setup.
7. Click <Start> and run the auto-calibration for one full cycle ((500s)x5=2500s=42 min)

IMPORTANT NOTE: while running the auto-calibration cycle, the profile plot on the screen will be changing continuously as the machine makes adjustments. It also may exhibit some unusual behavior. This auto-calibration plot is NOT used to verify final thermal calibration. The verification is done in manual mode afterward.

8. The software is set up to run 3 auto-calibration cycles in a row. After the 1st cycle, can continue following the software prompts and run the next 2 auto-calibration cycles (optional).
9. After completion of auto-calibration cycle(s), select <Finish> to save and exit the software calibration window.
10. The results of the auto-calibration run(s) must be verified in step 4.

STEP 4 (TOP): THERMAL VERIFICATION

NOTE: before running any thermal auto-calibration or verification, the TC reading from the probe should be ≤ 35º C. An external fan blowing on the TC probe/box fixture can be used to help cool down the system.

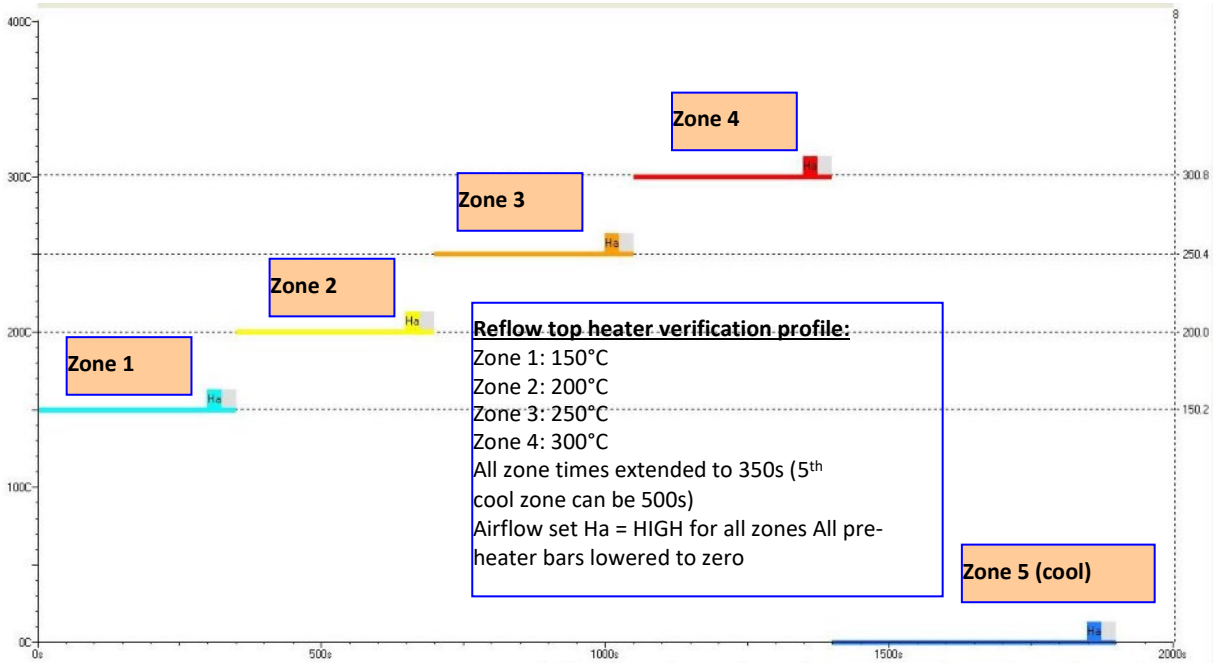
Allow TC3 to cool to 35° or less before running calibration or verification

1. To verify the top heater thermal calibration, keep the thermal fixture & probe in same positions as step 2.
2. Click <Process Setup> and select the manual mode.
3. Continue to the manual mode command window.
4. Lower all bottom heater temperature bars to zero.
5. Set all top heater airflow to Ha = high air.
6. Keep the default top heater thermal profile temperature settings:

   Zones 1-4 temperature bars are set at 150º; 200º; 250º; 300º C.

Extend time intervals for all 5 zones to 350s ea. (same time interval as auto-calibration).

(5th cool zone can be 500s)

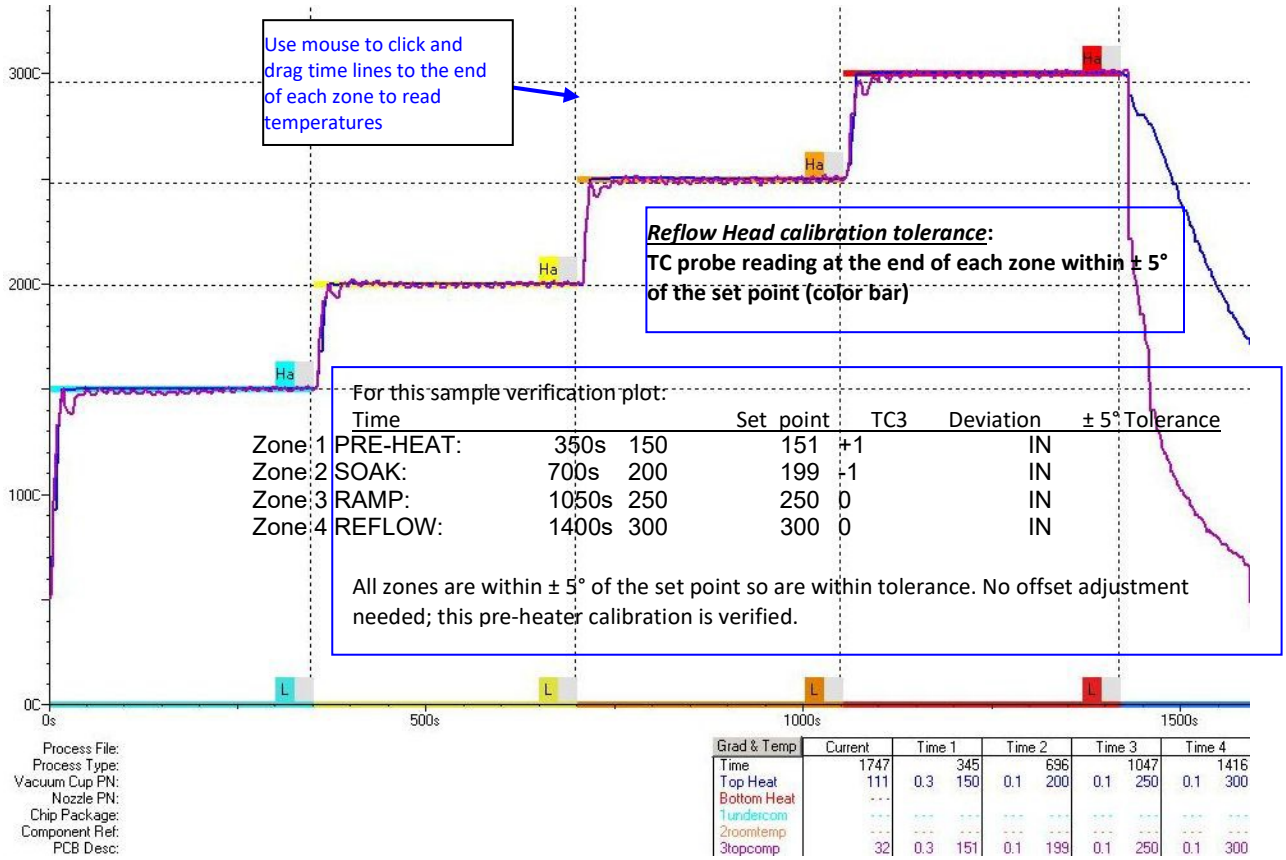


7. Click <start> to run the verification profile and finish the complete cycle.
8. After the cycle finishes, review TC 3 plot temperatures (from the probe) at the end of all 4 heat zones.

9. Position the vertical time lines at the end of each zone so that the exact TC 3 temperature can be reviewed at the bottom of the software screen: Time 1, Time 2, Time 3, Time 4.

(can also drag and set horizontal temperature measurement dotted lines for reference)

10. For all 4 heat zones, record the TC3 temperature deviation from the bottom heater color bar setpoints. Example: zone 1 color bar set point = 150º C. TC 3 reading at end of zone 1 = 157º C. Record the 1st zone deviation as 162 - 150 = **+ 12º C.** If TC 3 reads 195°C at the end of zone 2 then record 2nd zone deviation as 195 – 200 = - 5° C.
11. <u>Acceptable tolerance is TC 3 probe reading **± 5º C** of the set point to verify the top reflow heater calibration</u>.
12. If any of the zones are outside of this tolerance, can choose step 5 manual offsets or can run 1 or 2 more auto-cal cycles then verify again.



STEP 5 (TOP): OFFSET ADJUSTMENT

1. The thermal offsets for each zone are positive or negative "shifts" to heater thermal output in order to achieve calibration. These are adjusted automatically during the auto-calibration cycle and they can also be manually adjusted if any of the 4 zones in the verification run still do not fall within ± 5° C of the pre- heater set points.
2. Manual offset adjustments are based on the TC3 deviations from the set points, recorded in the verification plot (Step 4), and will be used to try to bring in the probe temperature readings at the end of each zone to within the ± 5° C tolerance.
3. After each manual offset adjustment, must run another manual mode verification profile to verify effect.
4. Exit the manual mode. In admin mode (refer to appendix) enter System Setup menu.
5. Select the <Profile> tab. The thermal offsets for each for the 4 zones for the top reflow heater are the 4 settings under **Top Heat Zone**.
6. The thermal offsets are not necessarily one-to-one (1 degree offset to 1 degree actual) nor are they necessarily linear. However, the first offset adjustments will be made one-to-one and a 2nd verification run to see to the effect.

Example: Zone 1 set point color bar is 150°. The TC 3 probe reading for the 1st verification run at the end of zone 1 was 157°. The deviation is 157 - 150 = + 7° C. The reading is high, and over the tolerance (155° maximum). In the profile window, if zone 1 offset is originally set at 39, the 1st adjustment should 39 – 7 = 32, or the one-to-one amount of the deviation. We will try to lower zone 1 output by - 7°.

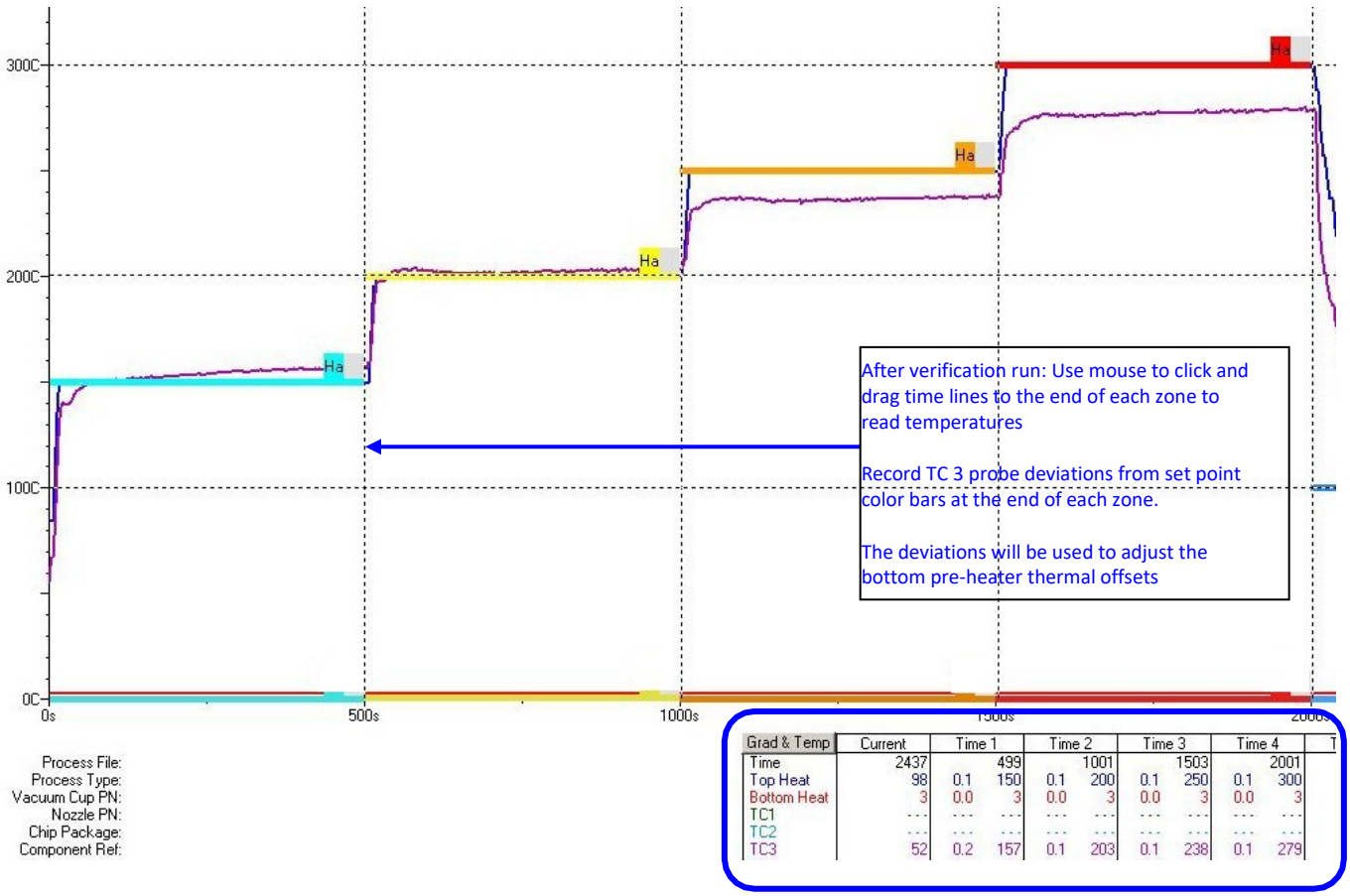
If the offset does not happen to be one-to-one, this will be seen in the 2nd verification run. For example, if we expected zone 1 to now be at 150° but it turned out to be 143°, or double the effect of what was expected. In that case we would assume offset roughly 1 to 2 and may adjust accordingly for 3rd run (use caution when estimating as results may not be linear).

For the following example, TC3 at the end of all zones is outside of the ± 5° of the set points so the offsets for all zones will need adjustment and the verification profile run again:

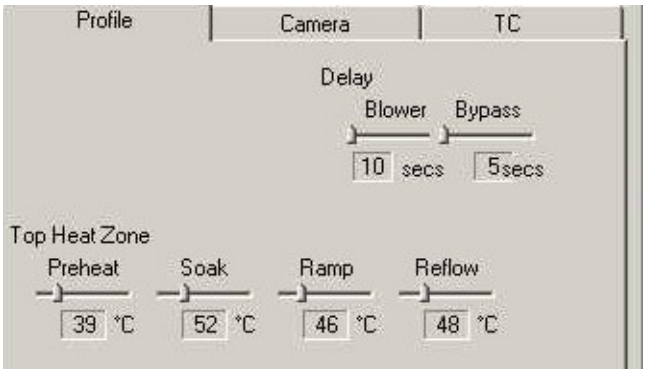
Example: SMPH Verification run	**Time**	**Set point (°C)**	**TC3 Reading**	**Deviation from set pt**	**±10° Set pt Tolerance**	**Manual offset adjust 1-to-1**	**Original offset**	**New offset**
Zone 1 (Pre-heat)	500s	100	117	+17	High +7	-17	45	28
Zone 2 (Soak)	1000s	150	139	-11	Low -1	+11	20	31
Zone 3 (Ramp)	1500s	200	183	-17	Low -7	+17	35	52
Zone 4 (Reflow)	2000s	250	267	+17	Hight+7	-17	72	55

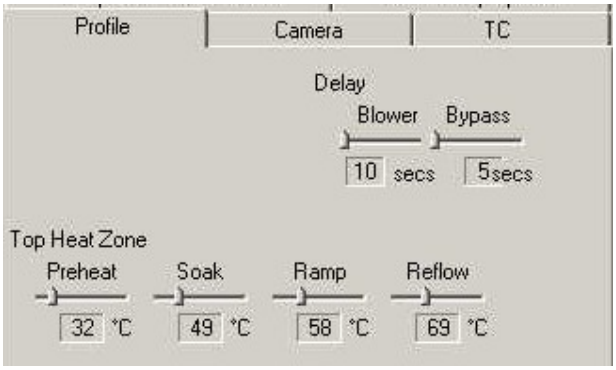
For the following example:

TOP REFLOW HEATER VERIFICATION PROFILE SAMPLE #2	**Zone 1 set pt 150°C (350s)**	**Zone 2 set pt 200°C (700s)**	**Zone 3 set pt 250°C (1050s)**	**Zone 4 set pt 300°C (1400s)**
TC3 reading verification plot 1	157	203	238	279
Deviation from set point	+7	+3	-12	-21
± 5°C tolerance (top reflow heater_	High	IN	Low	Low
Manual offset adjust 1-to-1	-7	-3	+12	+21
Original small bottom heater offsets	39	52	46	48
New adjusted offsets by deviation	32	49	58	69



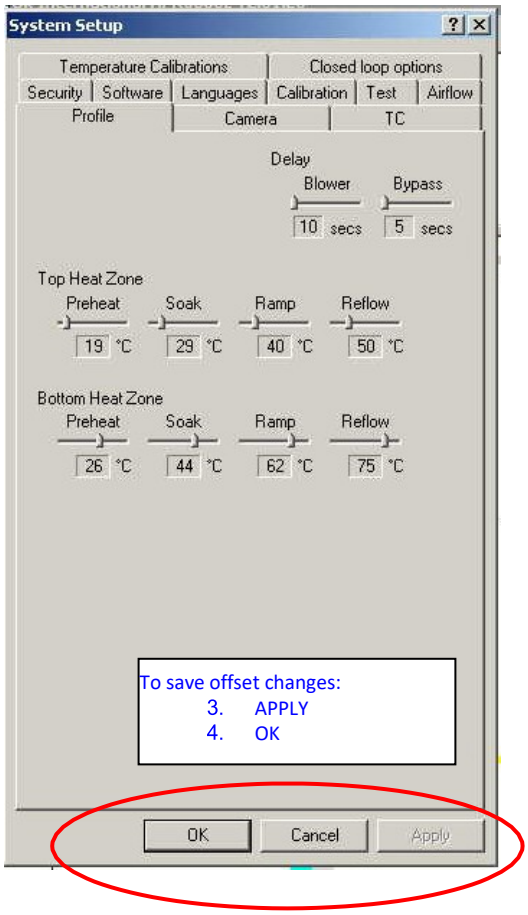
TOP HEATER PROFILE OFFSETS BEFORE ADJ: TOP HEATER PROFILE OFFSETS AFTER ADJ:





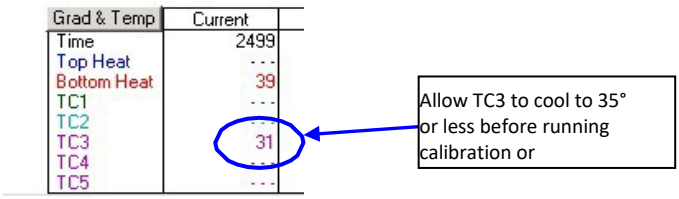
7. Using the recorded TC3 deviations from the verification plot, adjust the offsets for <Profile> Top Heat Zone in each of the 4 zones if out of the ± 5° C tolerance.
8. After making the offset adjustments, click <APPLY>, then <OK>.

The changes to the offsets will not be saved unless this is done.



9. In the manual mode, run the 2nd top heater verification.

Make sure the TC3 probe reading is cooled down to ≤ 35º C before starting the cycle again.



10. For 2nd run, review all deviations between set point and TC 3 readings at the end of each zone. If all 4 zones are within the ± 5º C tolerance of TC 3 probe to set point color bar then top reflow heater has been verified and calibrated.

If further offset adjustments are necessary, repeat above procedure for Step 5 until top heater is calibrated and verified.

Summary:

The top and bottom heaters have now been calibrated to factory standards.

The thermal offsets are saved in memory on the machine's control PCBA and not the software.

A record of all the thermal offsets should be saved for future reference by doing a print screen of the profile tab (see above) and pasting into a new picture or WordPad document.

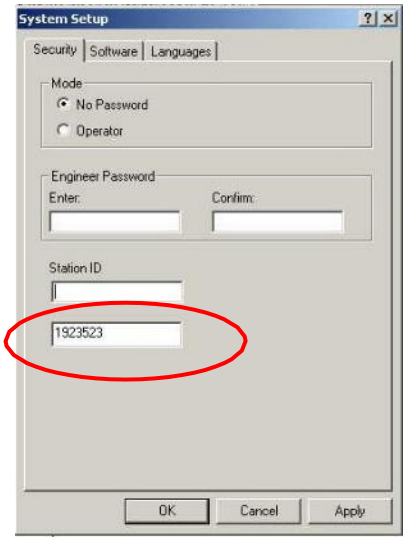
APPENDIX (A)

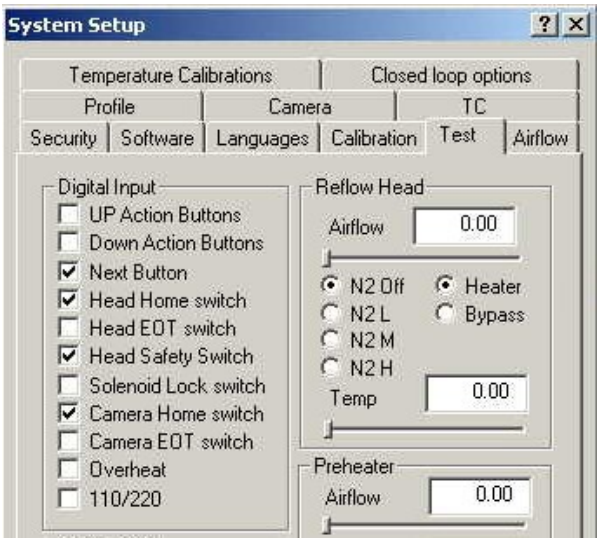
Software Engineer's Window (Software versions 2.01.20 and earlier)

Most of the following procedures require using the engineer's password in System Setup to access control windows.

1. Click the System Setup button in the software.
2. Enter administrator password 1923523 in the bottom space for Station ID and click OK button.

3. Click System Setup button again. All the test and calibration tabs should now be visible.





4. Click the software tab and enable the manual mode, which will be used in several of the following procedures.